The WHAT'S NEW magazine

Popular Science®

MAY 1987

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A SPA IS A SPA IS A SPA?

A CONSUMER GUIDE

If you've been considering a spa, you're probably already aware of the benefits and pleasures of whirlpool massage. However, not all spas are alike. The true test of any spa is whether it can provide these pleasures conveniently and efficiently. We'd like you to know what to look for when shopping for a spa and show you why the engineers who designed the HOT SPRING SPA® have produced the best spa available today.

1. FULLY WARRANTED MATERIALS AND CONSTRUCTION.

The HOT SPRING SPA is made of the most advanced and durable material of any spa - ROVEL™ **(A)**. Almost all leading manufacturers are turning toward this softly textured non-slip plastic because of its obvious superiority in spa applications. Unlike fiberglass or acrylic surfaces, ROVEL won't peel, blister, crack, or delaminate. As a result, ROVEL is guaranteed to be much more durable than any other spa material. In fact, while most acrylic manufacturers have reduced surface warranties to just one year, HOT SPRING SPA has stood firm with a full five years' coverage. HOT SPRING SPA is the oldest and largest manufacturer of ROVEL spas in the world.

2. CONVENIENCE AND EFFICIENCY.

Most spas have very little thermal insulation, some have none at all! Just how important is insulation? It's the most important feature in private spa ownership! Uninsulated spas will physically not operate in colder climates, making spa use as seasonal as a swimming pool. Further, a marginally insulated spa forces the heater to run continuously, costing you money. Many manufacturers try to compensate for the lack of insulation and their inefficient "air blower" systems by offering gas, 220v., or convertible heaters. While these options are viable in professionally installed, commercial or continuous use applications, they represent an unsafe, inconvenient, and costly alternative for residential use. The HOT SPRING SPA is filled SOLID with 130 lbs. of polyurethane foam insulation **(B)** and includes a 3½" thick insulating cover as standard equipment **(C)**. This heavy insulation makes it economical to keep the 110v. HOT SPRING SPA heated to your desired temperature 24 hours a day, regardless of location. You can use your HOT SPRING SPA at any time, day or night, in ANY climate, and for just pennies.

3. HYDROTHERAPY JETS.

Vigorous jet action is the key to true hydrotherapy. Only the HOT SPRING SPA gives you the option of powerful fixed jets (22 p.s.i. at each jet) **(D)**, and the unique stroking effects of the MOTO-MASSAGE™. The exclusive MOTO-MASSAGE JET glides gently up and then down the entire length of your back in a continuous sweeping motion **(E)**. In addition, we provide a "warm air" control which can be reached from inside the spa so you can vary the intensity of the jets **(F)**. These features combined with the STA-RITE Max-E-Glas pump provide the best hydrotherapy available today. **(G)**.

4. WATER CHEMISTRY AND FILTRATION.

Look for a large water capacity when shopping for a spa. Units that contain less than 180 gallons make it difficult to maintain proper water chemistry and require frequent draining. In addition, a larger capacity aids in heat retention. The HOT SPRING SPA contains over 325 gallons of water. Unlike many portables that have overlooked the value of good filtration, the HOT SPRING SPA features a huge 45 square foot filter **(H)**. Because of its size, it requires attention only 2 to 3 times per year. Its top loading design allows you to inspect, remove and clean it without draining the spa.

5. SEATING AND LIGHTING.

The HOT SPRING SPA features a split level seating ring, built deep for comfortable reclining and total immersion **(I)**. The barrier-free design eliminates the cramped, confined feeling of bucket seats, and allows you to move easily from fixed jets to moving jets or parts in between. The wide resting rim **(J)** provides an ideal perch for cooling off, or a safety bench for children. The HOT SPRING SPA also features an oversized underwater light with dimmer **(K)**. Colored bulbs can be interchanged quickly and safely to create different effects.

6. NO INSTALLATION.

Simplicity of installation should be checked. An in-ground spa is the most difficult, requiring backyard excavation, building permits and an expensive installation crew. Permanently wired 220v., and gas units are not much simpler, and completely eliminate the advantage of portability. The HOT SPRING SPA avoids these problems by requiring only common household current to operate (110v. dedicated 20 amp.) **(L)**. Just fill it up and plug it in. Its unique "treated grid" system requires no specific foundation for set-up and, as a portable appliance, you can take the HOT SPRING SPA with you when you move.

7. LISTED BY UNDERWRITERS LABORATORIES.

The HOT SPRING SPA is completely listed by Underwriters Laboratories, the recognized experts in testing for safety. The importance of correct and safe electrical design should not be overlooked. Check for the U.L. Mark on the outside of any spa you're considering - you'll see it on the HOT SPRING SPA.

We are proud of the quality features and performance we build into every HOT SPRING SPA. Each HOT SPRING SPA is an integrated design whose form follows function - the result of 10 years' evolution toward an ideal. So, before you buy any spa by any other name, see and *test* the HOT SPRING SPA. It's not the same.

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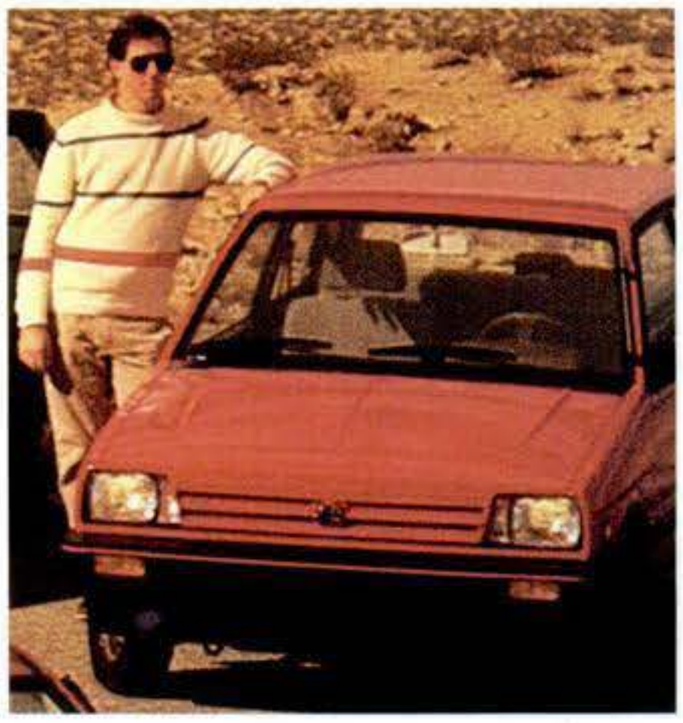
The WHAT'S NEW magazine
Popular Science®

MAY 1987
Founded in 1872/Vol. 230, No. 5

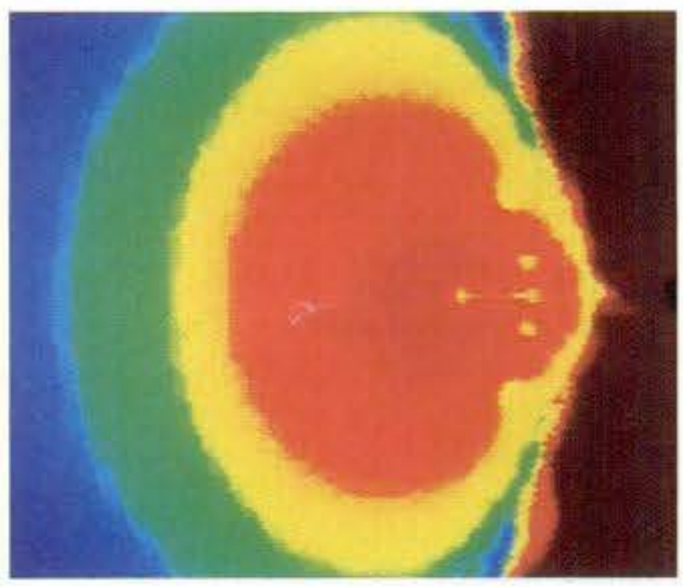
Minicars

A barrage of new cars from around the globe is invading the U.S. small-car market. These include the Ford Festiva, Hyundai Excel, Pontiac LeMans, Subaru Justy, Volkswagen Fox, and Yugo GV. PS puts these minis to the test and tells you how the new low-cost imports from Eastern Europe, Latin America, and Asia stack up against each other. **Page 42**



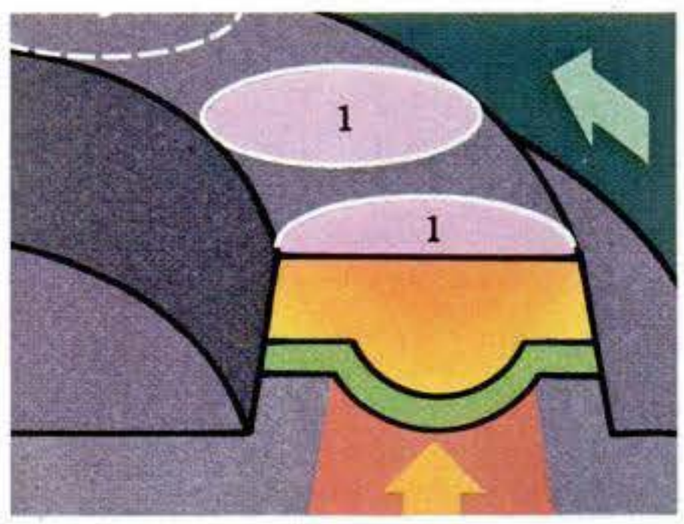
Supercomputers

Today's supercomputers can calculate in one second what would have taken a year at the end of the 1940s. Scientists can now solve problems that would have taken decades before. **Page 48**



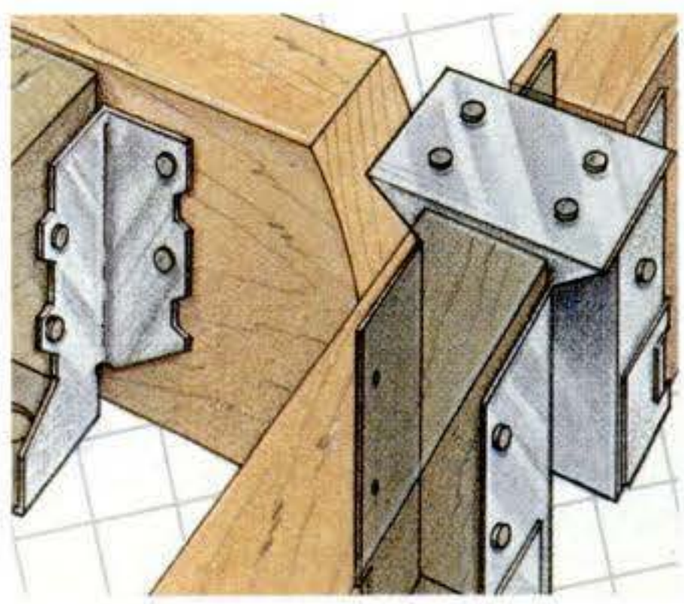
Optical discs

Optical discs can store 100 times more information than can regular magnetic floppy diskettes, and 10 times more than hard disks. Now a dramatic advance: high-capacity discs that can be erased and reused over and over. **Page 56**



Carpentry connectors

A bend here, a twist there, maybe a tab on the other side: Metal connectors may look puzzling, but the clever devices uncomplicate carpentry projects and boost joint strength. **Page 63**



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COVER PHOTO BY GREG SHARKO

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THE BEST GENERATORS ARE POWERFUL, RELIABLE AND QUIET. THAT'S WHY THEY'RE CALLED HONDAS.

Currently, Honda generators are the most widely-used, widely-trusted generators in the world.

Which should come as no surprise.

Especially when you consider that most Hondas are built around fuel-efficient, trouble-free Overhead Valve engines inspired by decades of world-class automobiles and motorcycles.

Or that Honda has the world's broadest range of multi-purpose generators from 650 to 6500 watts. For camping, boating, construction uses, power outages, outdoor parties, recharging car batteries—or most electrical needs at home or away-from-home.

Still, the real difference between an ordinary generator and a Honda generator can most accurately be summed up in one word: reliability.

The power you need is there when you need it. Because we engineer every single generator to ensure easy starts, quiet operation and durability that's measured in years—not months.

Honda generators. Quite simply the finest machines your money can buy. A claim no one else has the power to make.

HONDA Power Equipment

IT'S A HONDA

For optimum performance and safety, we recommend you read the owner's manual before operating your Honda Power Equipment. Connection to house power requires transfer device to avoid possible injury to power company personnel. Consult a qualified electrician. © 1986 American Honda Motor Co., Inc.

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C O R

The sport sedan is no longer designed by hand.

It is designed by the wind.

It's new Corsica.

It was conceived as a sport sedan to challenge the compact market.

It resulted in a sport sedan more aerodynamic than either Porsche 928 S or Ferrari Testarossa.

A sedan whose engine not only monitors itself, it monitors the driver.

A sedan whose manual 5-speed shifts so smoothly, it's almost automatic.

A sedan whose rear wheels help steer through turns.

A sedan whose front seats give people in back more room.

A sedan which, once it's painted, gets painted again.

Introducing the new 1988 Chevrolet Corsica, from The Heartbeat of America.

Put yourself into the smoothest Chevrolet sedan ever built.

And listen to your heart beat.

And the winds of change blow.

Let's get it together... buckle up.

GM 6/60 QUALITY COMMITMENT PLAN

*See your Chevrolet dealer for terms and conditions of the new limited powertrain warranty.

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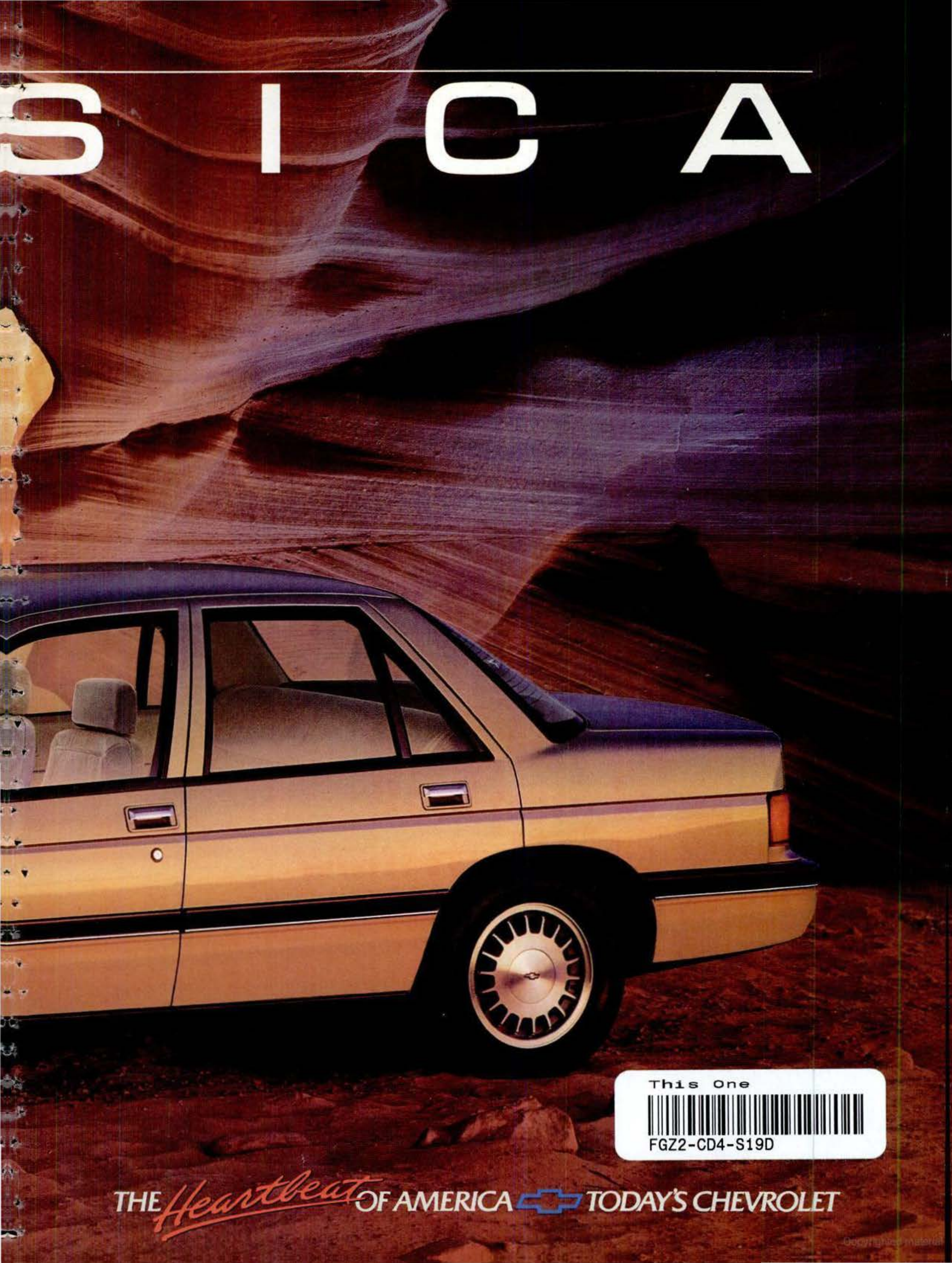

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THE *Heartbeat* OF AMERICA TODAY'S CHEVROLET

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Readers Talk Back

Wired against the law

"Short Circuits" by Bob Cerullo was particularly interesting [Feb.], but I found a technical error in the electrical symbols chart on page 108. The plus and minus poles of the diode are shown correctly, but the arrow for current flow is backward. Electrons flow from the negative pole to the positive.
William E. Hertwig Jr., Yonkers, N.Y.

Although it's true that electrons flow from negative to positive, auto engineers and mechanics follow a convention that says current flows from positive to negative. A typical light circuit starts at the positive terminal of the battery, then goes through a fuse, a switch, and a bulb before being grounded to the car body. Like many such conventions, this one doesn't jibe with the laws of physics, but it's useful in day-to-day life.—Tom Wilkinson

Don't cut corners

The solution offered in the February "Wordless Workshop" leaves the corners of the fireplace hearth and table exposed, which are even more hazardous than the edge. If the corners of the pipe insulation were mitered (instead of square cut) and glued together, the protection would be more complete and have a more finished appearance.
Jim Tanenbaum, Los Angeles, Calif.

Voice of Volvo

I enjoyed reading David Scott's article on the Volvo 480 ES in your February issue, but I must call your attention to one small error. Scott mentioned that Volvo Car BV, formerly DAF, already sold front-wheel-drive cars in Europe. This is incorrect. All Volvo production cars (and the early DAF) have been rear-wheel drive. The only front-wheel-drive Volvo prior to the 480 ES was our LCP 2000 advanced-technology car, shown in 1984. Some of this technology has found its way into the 480.
Robert C. Austin
Public Relations Mgr.
Volvo Cars of North America
Rockleigh, N.J.

The error was made during editing. Scott's original manuscript did not include the mistake.

Some words on waste

In the February article "Sludge Busters," you state that using water hyacinths to treat sewage would not work in large cities because of land cost, and that warm climates would be required because of the plant's temperature sensitivity. What if these sewage treatment ponds were stacked? Stacking the ponds and then enclosing them with some type of greenhouse structure would make them feasible in cooler climates with only minimal heating required, as well as multiplying the effective square footage.
Barney Morrison, Memphis, Tenn.

I was surprised that you didn't mention Walt Disney World in "Sludge Busters." It has been using this water hyacinth treatment method for about four years in an experimental sewage treatment plant.
Sean D. McGarrahan
Charleston, S.C.

Photo opportunity

Pretty picture, bad driving. The photo on pages 22 and 23 of your February issue shows the driver of a Chevy Beretta topping a hill and rounding a curve on the wrong side of a double yellow line. The "winding road" warning sign makes it apparent that the road is intended for two-way traffic.
David M. Hoban, Fort Worth, Texas

There are many things shown in car photos that you shouldn't try, and passing on a double yellow line is one of them. The road in question, a deserted two-lane in rural New York state, was momentarily blocked off while our photo was made. Incidentally, both cars were stationary during the shot.—Tom Wilkinson

Not-so-thorough insulating

I concur with Jan Kreider's response to the question of setbacks for gas heaters ["Alternate-Energy Answers," Jan.]. However, the recommendation to "thoroughly" insulate the heater might be misleading. Insulation should be kept clear of combus-

Continued

Address letters for this column to: Readers Talk Back, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We are unable to acknowledge unpublished letters.

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WINNER!

Top-rated radar detector beats Passport. Costs $115 less!

"It produced the earliest warning in our [road] tests."

Road & Track, *September, 1986*

Only 1¼" tall, 3¼" wide, and 4½" long. Fits in your pocket. Travels where you travel.

Shown actual size.

No doubt who won.

Road & Track magazine recently tested eight popular radar detectors. SNOOPER D-4000 won big. In actual road tests where it counts. Around the corner and over the hill radar ambushes. What about current best-seller Passport? ". . . second only to the SNOOPER D-4000." Sorry guys.

Fact: The SNOOPER D-4000 beats Passport on performance. **Fact:** It costs $115 less! No doubt who won.

"The SNOOPER D-4000 produced the earliest warning in our around-the-corner and over-the-hill tests."

Road & Track, *September 1986*

Sold on new high performance cars.

The SNOOPER D-4000 is made in Garland, Texas by Microwave Systems, Inc. — the inventor of solid-state radar detection for cars. The first to use superheterodyne

circuitry. The pioneer in remote devices. Maybe that's why SNOOPER came in first. Innovation and experience!

Until now, the SNOOPER D-4000 has been sold mainly through new car dealers. So you could wait and buy one with your next Porsche, BMW or Corvette. Or you can pick up the phone now and have one in your hands tomorrow. The SNOOPER D-4000 is NOT sold in catalogs, parts stores or discount chains.

All accessories are included.

Only $180! If you can afford one of theirs . . .

. . . why not buy TWO of ours? ONE Passport costs $295. For another $65, you can have TWO of ours. Protect other drivers in your family against radar surveillance, too. SNOOPER D-4000 is the top-performer, and at $180, it's the runaway winner for top value.

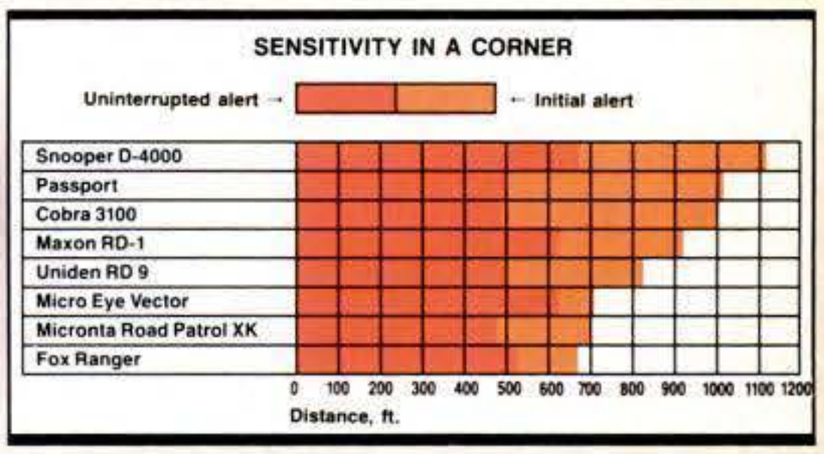
All the features you want.

The SNOOPER D-4000 is a triple superhet advanced radar detection device. Sniffs out both X- and K-bands radar, alerts you with a loud audible signal and simultaneous warning light.

Filters out false alarms, and "dirty" signals from other radar detectors. Comes with visor clip and dashtop mount. Plugs into car cigarette lighter. On/off and highway/city switches. Simple. No complicated dials or bar graphs to slow your reaction time.

Order today.

Order yours at no risk. Call toll-free to order. Drive with your SNOOPER D-4000 for 30 days. If not satisfied, return it and we'll refund your purchase and your shipping costs. Comes with one-year factory warranty. And, remember, it's the winner. The most for less. You can't go wrong!



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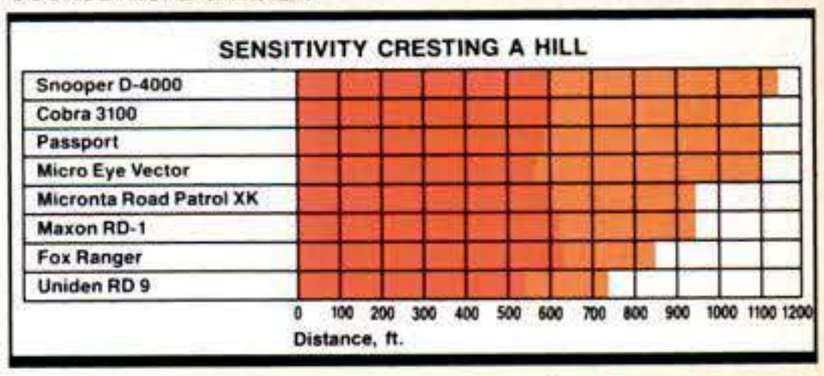

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tion air openings and should not prohibit airflow to the draft diverter.

Norm Moreau, Denver, Colo.

Power-scaffold danger

Your readers should know that a power scaffold like the one shown in your February issue (p. 41) is an extremely dangerous piece of equipment. If a winch is used for lifting personnel, it must be specifically designed and rated to do so. Otherwise, due to a lack of redundancy in general winch design and brake system, failures of any kind could lead to serious injury or death. In addition, the lack of limit switches and overload protection could result in the winch continuing to hoist even after it has been "switched off," leading to cable breakage and winch and cable-anchor failure. Although we sell winches with hoisting capacities in excess of a million pounds, we would never allow anyone to "hitch a ride" on one.

Robert L. Peterson, Pres.
Allied Power Products, Inc.
Beaverton, Ore.

Still at it, adiabatic?

Several years ago [April '83] you ran a particularly interesting article about Smokey Yunick's Phase I adiabatic engine. Whatever happened to it?
Richard Brampton [address withheld]

At this time the engine is being considered for limited production by an American car manufacturer; it could appear either in a vehicle or on the showroom floor within 18 months. A kit form of the invention for four-cylinder engines is also being considered for the marketplace. Although Motor Tech, a Daytona Beach, Fla., company, has been battling to commercialize the engine for several years, it turns out that such a major change in technology is not easy to market without a lot of testing.—Smokey Yunick

No endorsement for wrap-up

Contrary to your reply to the March letter Dangerous Asbestos Cleanup, the National Safety Council does not endorse this procedure. Admittedly, asbestos abatement procedures can be expensive; but the described wrap-up procedure cannot be relied on to protect the homeowner and other residents from asbestos exposure while wrapping and in the future. The safe handling of asbestos is a complex matter and cannot be conveyed to an untrained individual in one short paragraph. If a homeowner believes he has asbestos in his residence, he should consult the EPA Regional Asbestos Coordinator or the American Industrial Hygiene Assn. in Akron, Ohio [(216) 762-7294].

George S. Benjamin, M.D.
Dir., Occupational, Environmental and Consumer Health
National Safety Council, Chicago

We did check out this procedure with an individual at the NSC, but apparently his opinion is not coincident with that of the director of this department.

Longer-life batteries

Nickel-cadmium batteries and nicad-battery-operated tools are some of the greatest new contributions to my tool chest. Unfortunately, I've already lost one tool—a flashlight—to a dead battery. How should these cordless tools and batteries be stored?

John Grabouski, Lincoln, Neb.

Lou Vassos, product design engineer for Skil cordless tools, gives these tips for prolonging the life of nicad batteries: "Don't store tools or batteries in a hot location or in direct sun, and use the tool often; batteries thrive on work."

Buy American?

I read with interest Robert Rassa's comment regarding the nearly $80 cost for a taillight lens for a German-made Scirocco ["RTB," Jan.]. I recently had to pay over $100 for a taillight lens for a 1985 American-built Oldsmobile Delta 88—with no installation and no frame. I'm a supporter of "Buy American," but things like this make you wonder.

W. L. Zimmerman
North Hollywood, Calif.

Tool for the job

The advice given in December 1986's "Taking Care of Your Car," to use a socket wrench to install a new freeze plug, is unsafe. The reason: Most sockets are hardened and could break easily, even if struck with a soft drift punch. I conduct safety meetings for industry, and stress that people use the right tool to avoid injury.

Morgan McLain Jr.
Industrial Representative
Snap-on Tools, Pascagoula, Miss.

Correction: The correct address for Black & Decker security systems is 6 Armstrong Rd., Shelton, Conn. 06484 ["Cop in a Box," April]. PS

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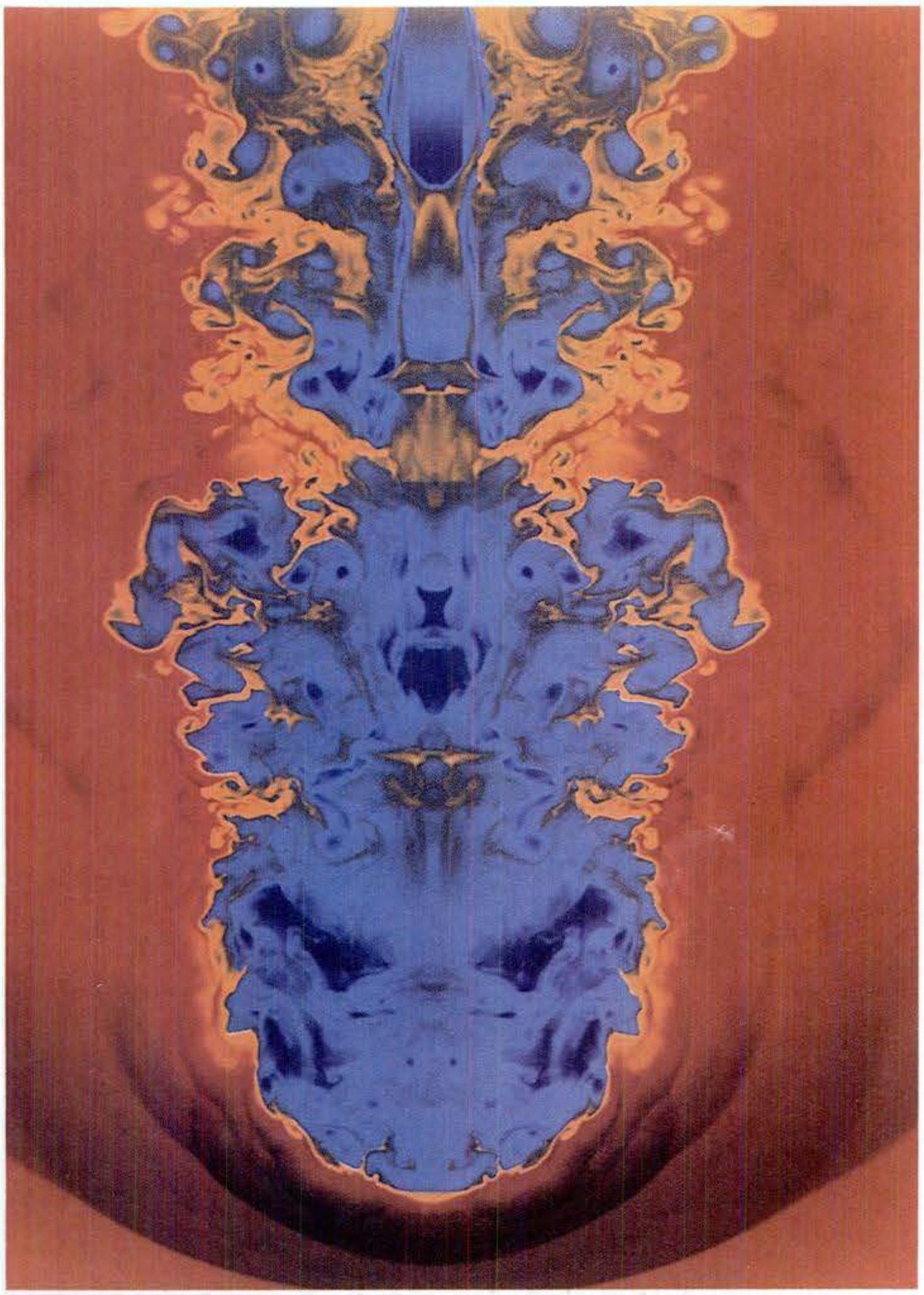
Science Newsfront

By ARTHUR FISHER



A graphics simulation using supercomputer data captures a supersonic gas flow.

Shocking pictures

Physicists studying the phenomenon of turbulence in fluid flow have always faced a severe problem: getting an accurate picture of what actually happens, instant by instant. Such information is essential for understanding, and coping with, the turbulence found in oil pipelines, internal-combustion engines, airplane-wing vortices, and majestic storms. To visualize turbulent flow, specialists have devised clever techniques, including various kinds of photography. Most are beset with difficulties.

One way to get around the problem is to simulate the phenomenon on a supercomputer [see article, this issue]. But the torrents of numbers generated for even a simple case are not readily graspable by the human mind. The solution: the kind of high-speed graphics shown here.

Karl-Heinz Winkler, member of Los Alamos National Laboratory's Applied Theoretical Physics Division (Los Alamos, N.M.), was investigating the behavior of a gas being shot at supersonic speeds into a second gas. He realized that by turning reams of numerical data into graphic displays, he could let the eye see the actual process taking place. "We took technology that was from three to ten years old," he says, "and hooked it together to present the brain and eye with images of the gas flows we study. By converting the computer's numerical data into images, and by using high-speed communications lines, we have speeded up the collection of information by a factor of seven thousand."

This computer simulation shows gas being rifled at supersonic speed through a small opening in a tube, forming a beam. The tube contains a second gas, through which the beam travels. Swirling shock waves can be seen on either side, and a bow shock can be seen racing ahead of the beam.

Eastern earthquake?

Warnings of an imminent (well, within 25 years, anyway) earthquake on the West Coast have come so frequently that they are boring some people, including those whose houses straddle the San Andreas Fault.

But a major quake in the East? Fasten your seat belts. A report by the prestigious American Association of Engineering Societies, representing more than a half-million engineers, predicts a major earthquake—6 or higher on the Richter scale—in the eastern United States within the next 25 years, with near 100-percent probability. It could, the report states, have devastating consequences for the energy distribution system in the region, disrupting electrical, oil- and gas-pipeline, river, and rail distribution networks.

The AAES report, prepared by a subcommittee of its Coordinating Committee on Energy, was reviewed by industrial and academic experts on earthquakes and energy. "Our purpose in conducting the study was not to present a doomsday situation," says the paper's principal author, Dr. James E. Beavers, "but to raise public awareness of the danger and encourage research, planning, and construction needed to reduce potential hardships."

The eastern U.S. holds 80 percent of the country's population. Eighty percent of all electrical energy used

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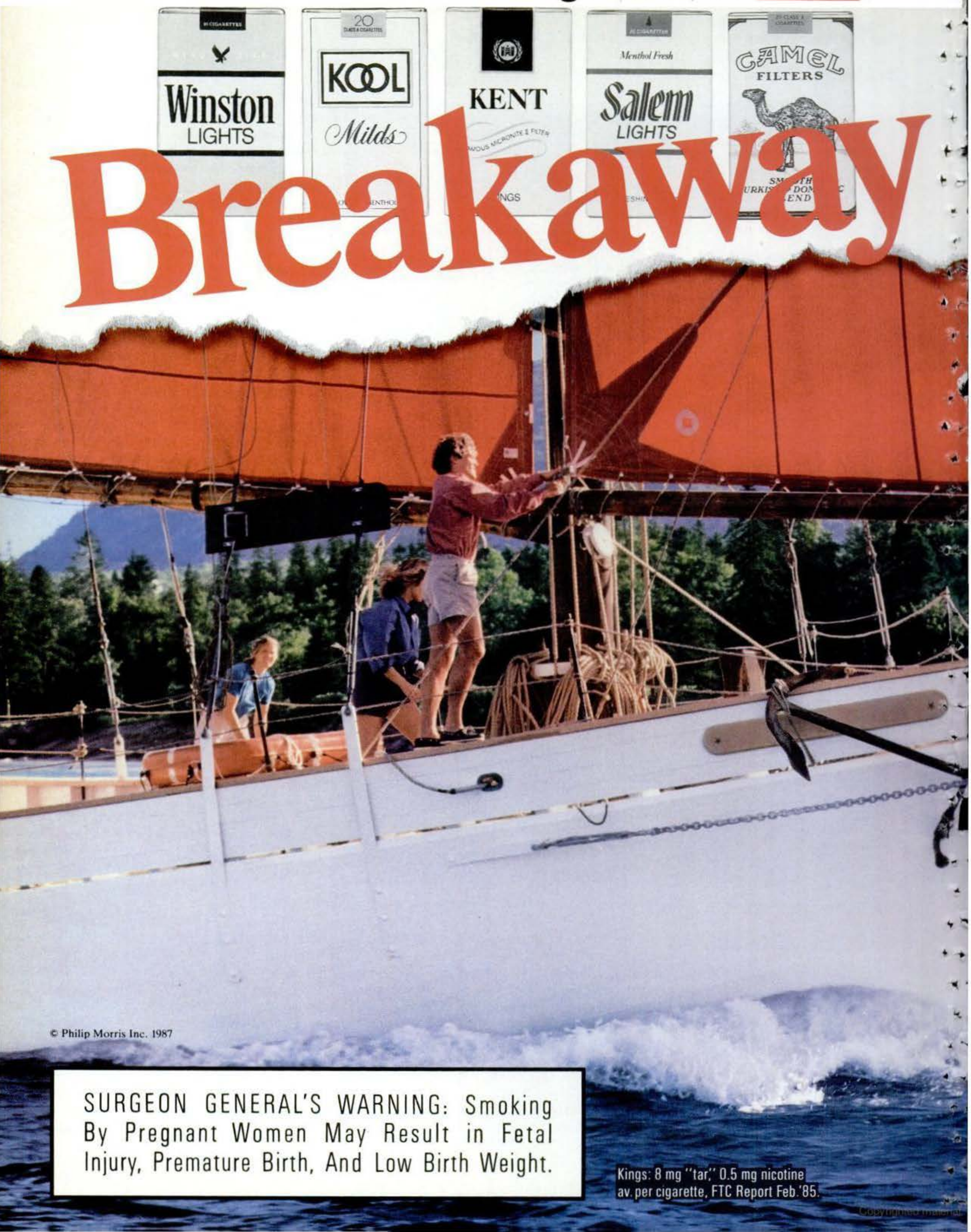

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Comparisons based on king-size versions of product shown and tar levels from latest FTC report.

This new "personal" robot, designed to fill the gap between toys and costly industrial machines, can handle many complex tasks.

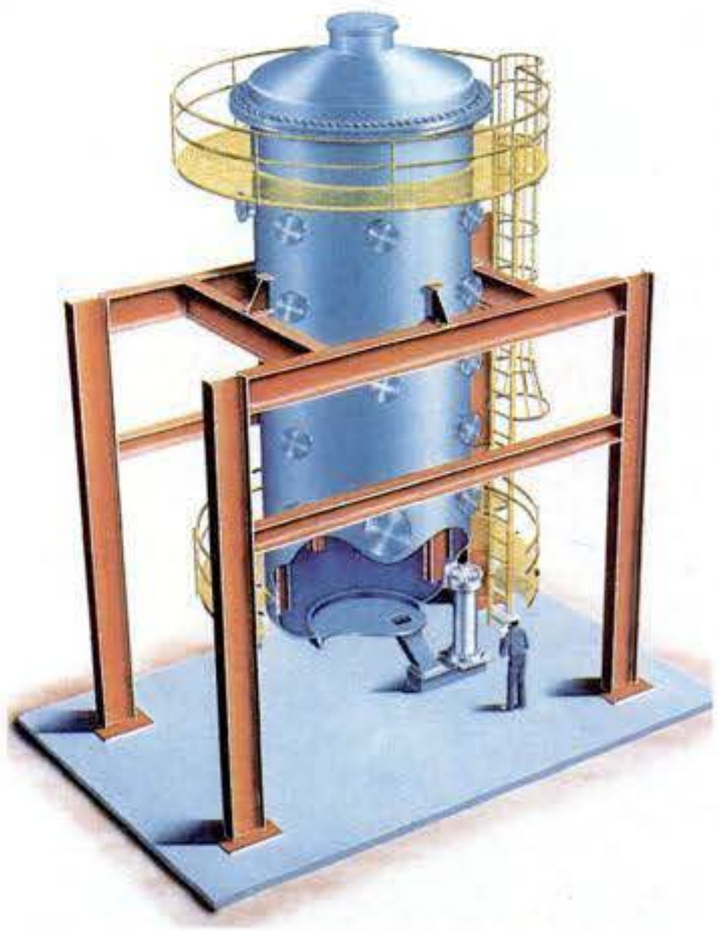
in the U.S. is distributed east of the Rocky mountains. And pipelines from Texas, Louisiana, and Oklahoma ship the equivalent of 25 percent of total U.S. energy consumption to the heavily populated areas of the Northeast.

According to the report, the greatest earthquake threat is to the Mississippi Valley, followed by Charleston, S.C., and vicinity. "The earthquake threat in the eastern U.S. is real. The only uncertainty is where and when. When such an earthquake occurs, it is important . . . to be prepared in order to mitigate the effects. This can only be done through effective research, construction, planning and public awareness."

Personal robots

The RTX, seen in the photo above, has been developed by the London-based Universal Machine Intelligence Co. to mate with inexpensive personal home computers, filling the gap between the toy robots now available and expensive industrial robots. The RTX costs $7,500, roughly 10 times less than a typical industrial robot, and can be controlled by even the cheapest personal computer.

RTX's six-axis arm has a reach of 24 inches and can lift 4.4 pounds to a height of 36 inches. It can position objects, such as the circuit boards in the photo, to an accuracy of 0.039 inch within a space of 28 cubic feet. It is now being used by research organizations in Europe and the U.S. for functions ranging from helping paraplegics perform laboratory experiments to making T-shirts.



Surtsey, a 1/10-scale nuclear-reactor-plant replica, simulates meltdowns.

Simulating meltdowns

The test facility in the painting below is named (obviously by someone with a rather macabre sense of humor) Surtsey. Surtsey is a tiny island off the Icelandic coast. It was born in the months-long eruption of an underwater volcano in one of the most violent and spectacular natural episodes ever witnessed. The Surtsey now operating at Sandia National Laboratories in Albuquerque, N.M., is designed to simulate one of the most feared types of nuclear-reactor accidents: the high-pressure ejection of molten fuel-core debris, gases, and steam through the bottom of a ruptured pressure vessel and into the plant's containment building—at temperatures of 3,500 to 4,500 degrees F. The objective is to determine whether the tremendous energy involved could damage the steel-and-concrete containment shell, the final barrier between a nuclear plant's radioactivity and the environment of the world outside.

"Smaller-scale and less realistic experiments and computer analyses suggest that these events could produce significant loads on a containment building," says Bill Tarbell, Surtsey's project leader.

Surtsey stands 34 feet tall; its diameter is 12 feet. This volume is roughly equivalent to a 1/10 linear scaling of a large nuclear-plant containment building. It has a similarly scaled pressurized water reactor (PWR) pressure vessel; PWRs are the most common nuclear-reactor design for generating electricity. In a loss-of-coolant accident in a PWR, the fuel rods, consisting of uranium dioxide pellets in zirconium cladding, could heat up to 5,000 degrees F. The result would be that the fuel rods would slump and, along with other metallic components, melt to form a molten core debris pool at the bottom of the pressure vessel. Welds there might fail.

Sandia researchers will investigate this accident scenario with a series of 11 Surtsey tests, using simulated molten debris pools weighing up to 180 pounds. The work is sponsored by the U.S. Nuclear Regulatory Commission. Sandia is operated for the Department of Energy by AT&T Technologies. PS

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The gearcase of the Hitachi Mighty Miter is supported by two hinges. This ensures less deflection and more accurate cutting.

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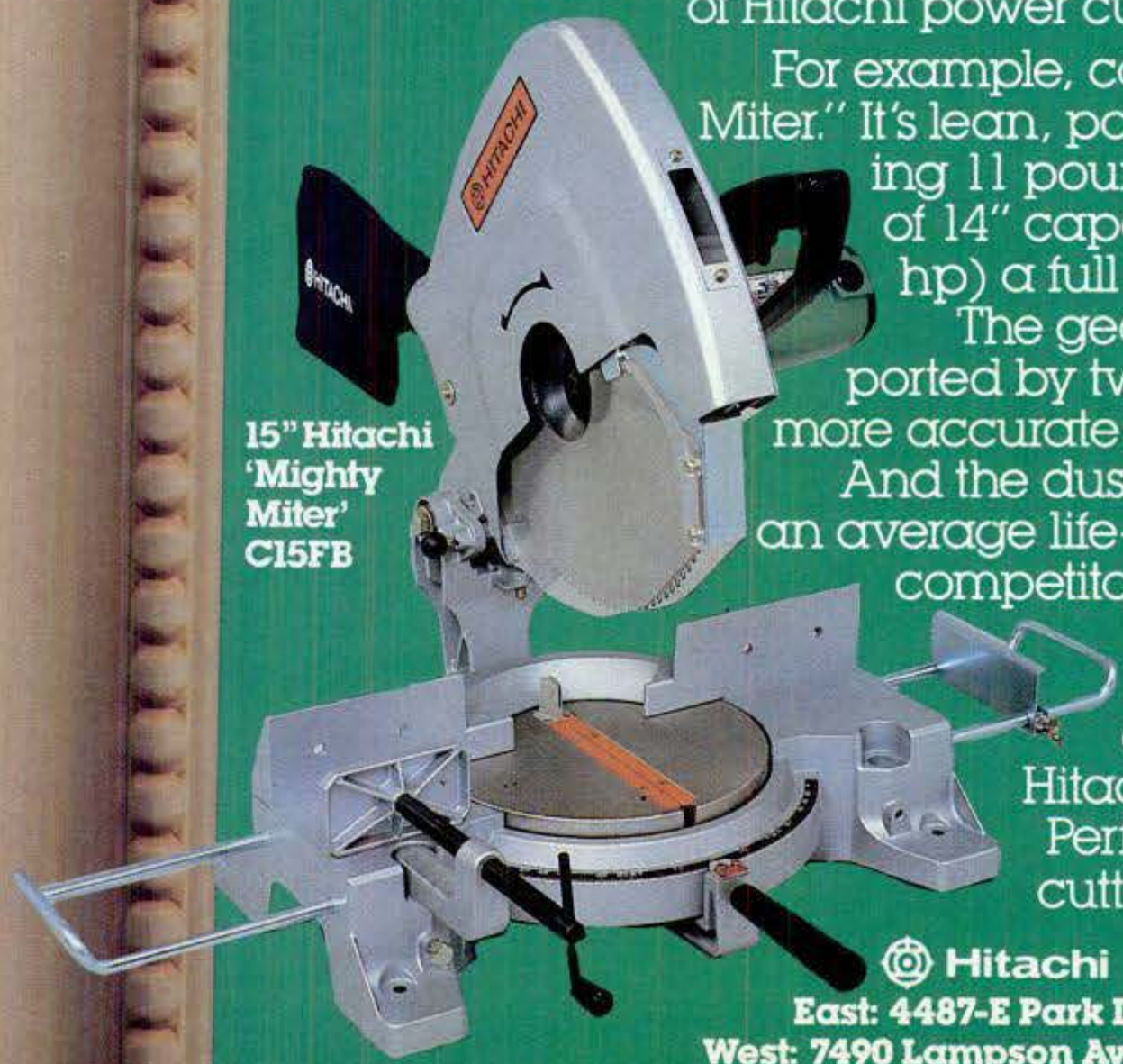

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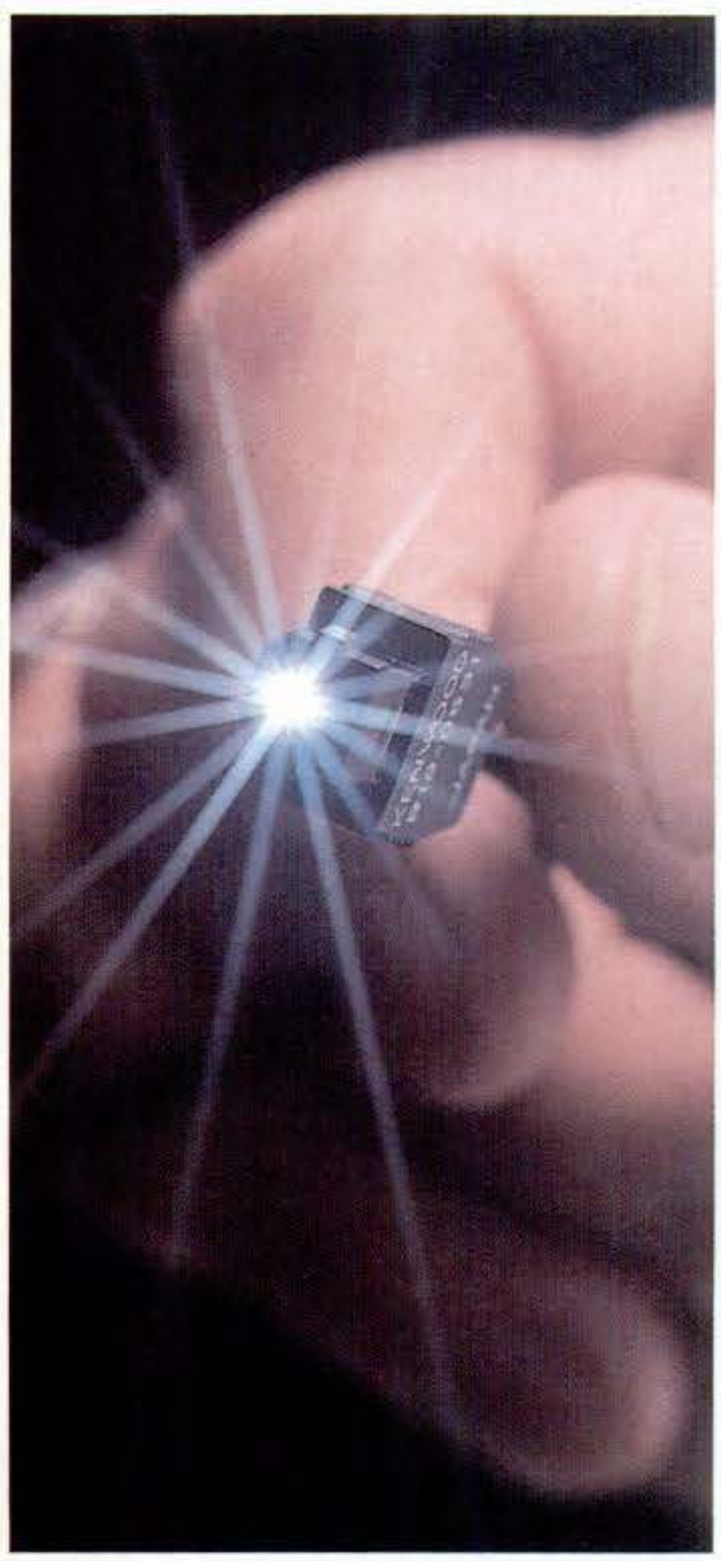
Electronics Newsfront

By WILLIAM J. HAWKINS



A beam of light connects Kenwood's CD player to its amplifier. Conventional analog and digital inputs can be used, too.

Light music

"You don't have to be an audio engineer to hear the difference," says Mike Ranney, national sales training manager for Kenwood U.S.A. Corp. "It's very clear." You needn't be an engineer to *see* a difference in Kenwood's new KA-3300D amplifier ($1,199) and DP-3300D compact-disc player ($850), either. A tiny beam of light tells you something's unusual.

The light (above left) comes from within a fiber-optic link that can be used in place of the well-known RCA Corp. phono plugs and coaxial wire to attach audio peripherals to the amplifier. Analog audio signals—sent through a wire—are not used. Instead, the light contains the audio in digital form.

"Normally, there's a signal loss between the disc and amplifier," explains Ranney. "There's a current drop in the wire, and induced magnetic fields increase electrical noise." With the fiber-optic link, the audio is used to digitally pulse the light; in the amplifier, a digital-to-analog converter reconstructs the analog signal, and it's played normally. "There are no signal losses," says Ranney, "and no induced noise. The sound is exactly as it is on the disc."

There is no standard for optically coupling hi-fi equipment, so only the Kenwood CD will work this way. "When someone comes out with something first," says Ranney, "that usually becomes the standard. And we intend to have other optically coupled gear soon."

What other gear? Ranney won't say, but a Kenwood digital audio tape (DAT) recorder is ready to hit store shelves. The amplifier can also accept a conventional digital signal from other CDs, DATs, and direct digital satellite transmissions via a coaxial input.

The KA-3300D has a digital output for DAT recording, too. Will the amplifier allow direct recording from a CD? "No," says Ranney. To avoid digital-to-digital copying (frowned on by the CD industry), the CD audio passes through the digital-to-analog converter, then through an analog-to-digital converter for taping. "It's not perfect," Ranney says, "but the sound is as clean as you can get."

Lightest PC portable

Your briefcase just lost a few pounds: The GridLite portable computer from Grid Systems (2535 Garcia Ave., Mountain View, Calif. 94043) weighs just 8.5 pounds, down two to four pounds from other briefcase-size models. The $1,750 unit, with 10-inch diagonal liquid-crystal-display screen, accepts up to 640 kilobytes of random access memory (RAM) and one megabyte of optional ($395) expanded memory. This memory uses the Lotus-Intel-Microsoft standard, which allows it to be used as a RAM disk. (The computer

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"thinks" it's saving data on a disk for faster operation.) The computer also accepts up to one megabyte of plug-in read-only memory that can be preprogrammed with software for nearly instant use.

$150 camcorder

"It's so simple, a child can use it," said a spokesman for Fisher-Price Electronics (636 Girard Ave., East Aurora, N.Y. 14052). It better be: The newest camcorder is designed for children. But despite the age of its user, the PXL 2000 is technically mature. It records for 11 minutes on a standard 90-minute audio tape, and it plays back on any TV. Unlike other camcorders, which maintain the high head-to-tape speed needed for video recording by spinning the record head across the tape, the PXL 2000 whips the tape quickly past a stationary head. The technique works, but the bandwidth—the amount of picture information the camera is capable of recording—is narrow. Result: rather poor black-and-white pictures, according to an on-the-scene PS editor. Although the picture quality might not be up to professional scrutiny, it's fine for kids. And at $150—compared with $1,200 for a standard camcorder—it's not bad for parents, either.

Instant-retrieval VCR

JVC has completed work on its VHS coding system for VCRs. The system uses the control track of VHS tape to hold binary data, but how the information is used is up to machine makers. Some ideas: For TV shows, programs can be numbered for quick searches in either fast-forward or rewind modes. And for home movie making, dates and times can be recorded with the image for reference.

CDs you watch

Jan D. Timmer, chairman of PolyGram International, held one of the first five-inch video compact discs in his hand. "CD video merges the digital audio of compact disc with the video of LaserVision," he said. That was fast: Just a few days earlier Sony Corp. and N.V. Philips of the Netherlands agreed on the specifications for a new audio-video disc player. The player, which is to be shown to dealers this summer, uses conventional five-inch CD audio discs, 8- and 12-inch LaserVision video discs, and the new five-inch video discs that contain five-minute music-video singles. Sony and Philips are also planning a three-inch-diameter CD that holds up to 20 minutes of audio. With an adapter, it will be compatible with existing CD players.

Speak to it

IBM Corp. has developed a new PC-based 20,000-word experimental speech-recognition system. (The company showed a 5,000-word system just recently.) As with other recognition systems, as you say a word, it appears on the screen. But the process by which the computer recognizes each word is different from those of the past. The system is speaker dependent: It works with only one person at a time and must first learn your way of talking. To do that, you read a specially prepared document in a 20-minute training session. As you speak, the computer extracts 200 sound patterns that characterize your speech.

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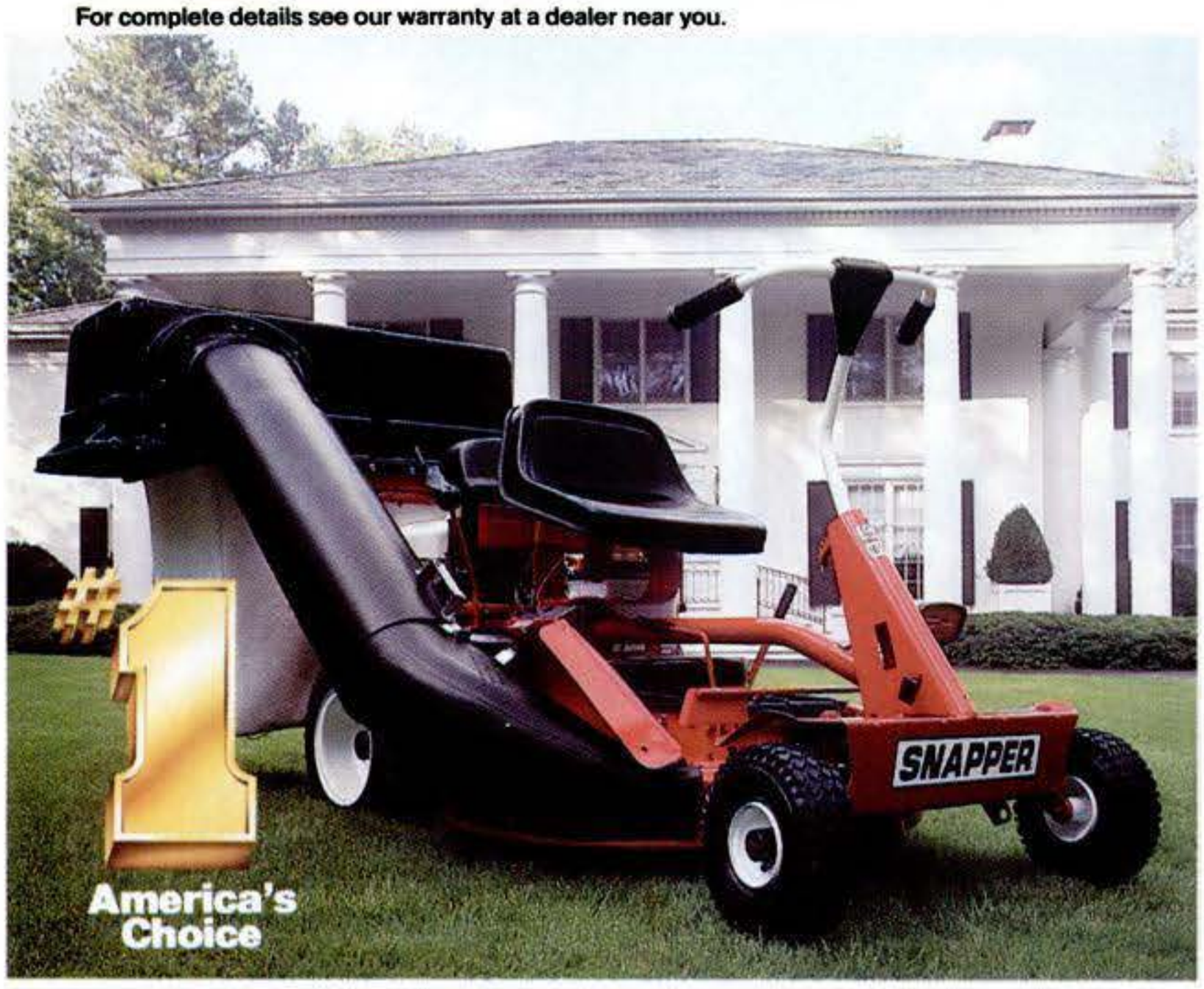

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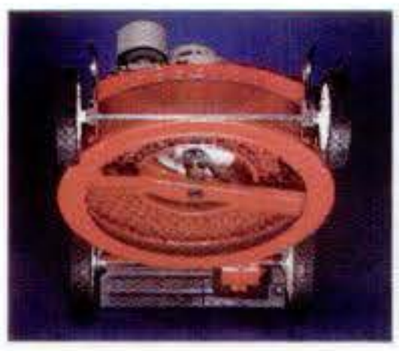

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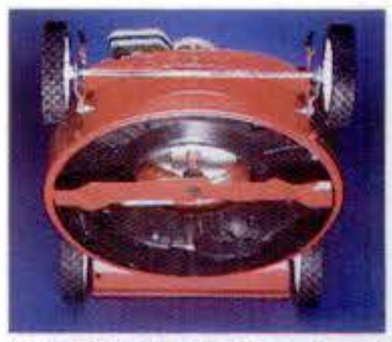

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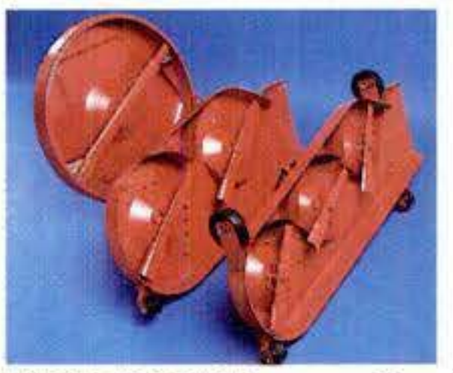

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through a two-step procedure. First, it compares the patterns of the spoken word against others in its vocabulary, and chooses those most near a match. Then (and here's the tricky part), it checks the candidates against *25 million* words gathered from IBM office correspondence. A second or so later the word that best fits with other words in the sentence is displayed. Because the system bases its selection on sentence context, words like "know" and "no," and "to," "too," and "two" are selected correctly. According to IBM, the 20,000-word vocabulary represents about 97 percent of the words a speaker is likely to use.

High-frequency amplifier

General Electric Co. has developed a High Electron Mobility Transistor that can amplify a 94-gigahertz (billion hertz) signal. That frequency is particularly important to ground-to-space communications. In that range the atmosphere provides a "window" —it does not absorb the signal as it does at lower frequencies. The result could mean small, low-power earth-to-space communication devices in the future.

Computer-aided speech

According to the American Speech-Language-Hearing Association, three out of every 100 schoolchildren have a speech impairment. Professional help for these students is costly and limited. Now, a computer system from Matsushita Electric Corp. (One Panasonic Way, Secaucus, N.J. 07094) has proved successful after a three-year evaluation period. The speech-therapy system displays syllables that are to be spoken, then uses sensors attached to the child's nose and throat to evaluate how the sounds are made. The data are used to graphically display the correct position of the tongue for a better pronunciation. The instant feedback allows the child to continually adjust his or her speech to correctly match the sound.

Growing memories

IBM Corp. will be using a one-megabit memory chip in a new version of its RT personal computer. The company also has a four-megabit chip ready for production. Meanwhile, Nippon Telegraph and Telephone Corp. is poised to release information on a new 16-megabit chip. That's enough bits for a single chip to hold about 1,000 pages of text. PS

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Automotive Newsfront

By DAN McCOSH Detroit Editor

The 1990 Dodge Daytona will feature V6 power and either full-time four-wheel drive or computerized traction control.

PHOTO BY HIDDEN IMAGE

GM's plastic van, the APV 200, is expected to roll into the showrooms in 1989.

Future Daytona

The Dodge Daytona, one of those automotive workhorses that seems to please most of the people most of the time, finally appears to be ready for a make-over. By 1990, the Daytona will have a new body shell, a new engine, and a cure for torque steer, the light steering and instability that plague powerful front-drivers. At least that's the word from sources working on the next generation of Chrysler's sporty coupe.

The current Daytona, introduced in 1984, was freshened up this year with rounded corners and more horsepower. But it's still based on a slightly stretched K-car platform, and powered by Chrysler's venerable 2.2-liter four-cylinder—albeit a turbocharged, intercooled version that generates 174 horsepower.

But both body and power train are near the end of their development cycles, and we got a peek at the future Daytona in the form of the latest styling exercise done by Chrysler's Highland Park, Mich., design center. According to people close to the program, this new Daytona will feature both a V6 engine and some form of traction control.

Such features may become standard on performance cars of the 1990s. Work at Chrysler and elsewhere has shown that a V6 engine can generate plenty of scoot for a car the size of the Daytona. But experimental work with front-drive cars and engines of 200 horsepower or more has resulted in unacceptable torque steer and handling problems, say Chrysler engineers. Under some conditions, even the current Daytona scrabbles for traction like a cat climbing the curtains. The search for a solution is following two paths: One would use a computer to hold power output to just below the point of wheelspin. The second involves full-time four-wheel drive.

Chrysler, like many companies, has reservations about currently available four-wheel-drive technology. Favored so far is a viscous-differential system developed in conjunction with Britain's GKN, although questions remain aboutits ability to deliver smooth performance under certain load and steering conditions.

Space van takes off

The second high-volume vehicle to be built with the space-frame construction first used on the Pontiac Fiero will be a six-passenger front-drive mini-van that GM could be selling by 1989.

Now called the APV 200, the new van is expected to be built by assembling a steel cage, then attaching large interior and exterior panels made from molded plastic. The van program recently got the go-ahead, and an assembly plant in North Tarrytown, N.Y., has been chosen. Production of some 200,000 vans a year will begin in late 1988.

Simple springs

Old ideas, like old soldiers, never die. Many never even fade away. An Anglo-

Continued

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The Yamaha Terrapro.™ Think of it as a Veg-O-Matic for the yard.

It mows. It tows. It sprays. Introducing the Yamaha Terrapro.™ The first all-terrain four-wheeler designed to

The secret behind the Yamaha Terrapro is the PTO that lets you work mowers and sprayers.

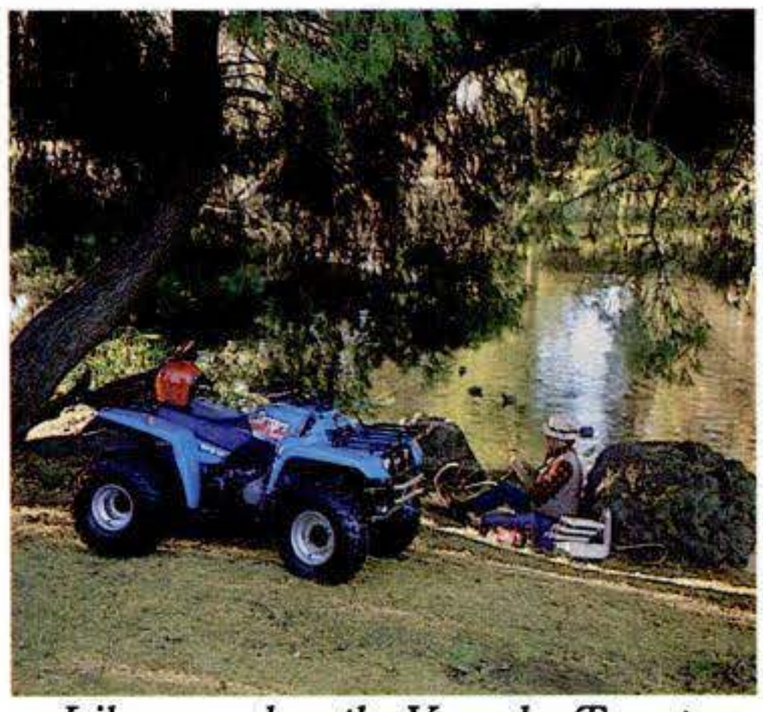
work around the yard. Or down on the farm.

Because it's the only four-wheeler that has a rear-mounted ASAE standard 1-inch 2,000 rpm, 10 horsepower PTO (Power Take Off).

Translated, that means the Terrapro has a PTO power hookup in back that can operate a variety of mowers and sprayers.

For example, our Yamaha mowers made exclusively by Woods. The 48-inch finish mower makes having neatly trimmed lawns as easy as sitting down. While the Yamaha 42-inch rough-cut mower eats up grass, weeds and light brush.

For spraying fertilizers, herbicides, or insecticides,* there's our Yamaha system of sprayers manufactured by Broyhill. They come in 50 and 100 gallon sizes with a convenient hand-held sprayer. And you can get an efficient 15-or 24-foot boom. Both boom systems have a modular design that can be arranged into various configurations, so you won't be.



Like you, when the Yamaha Terrapro isn't working, it's playing.

A Yamaha mower trims hours off your workday.

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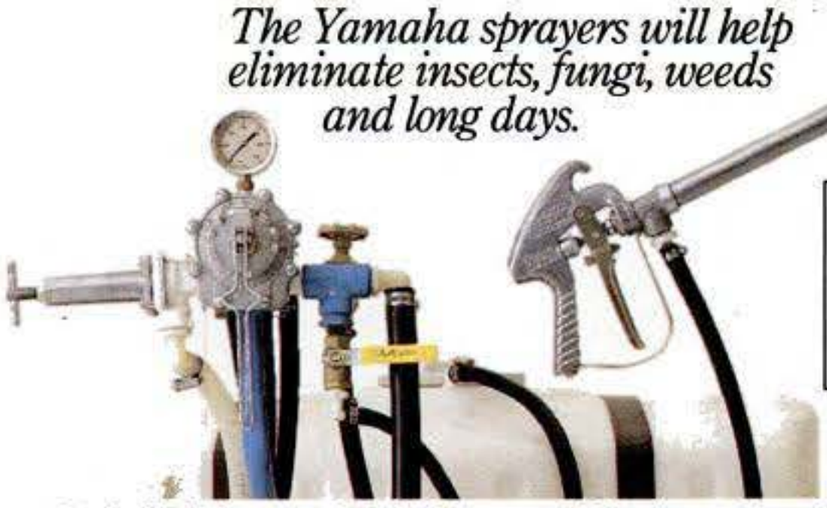
The Yamaha sprayers will help eliminate insects, fungi, weeds and long days.



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180 day limited warranty includes Terrapro and Yamaha sprayers and mowers. Warranty terms are limited. See your Yamaha dealer for details. Dress properly for your ride with a helmet, eye protection, long sleeved shirt, long trousers, gloves and boots. Specifications subject to change without notice. Designed for off-road, operator use only. This product is to be used by one person only. Yamaha and the Specialty Vehicle Institute of America encourage you to ride safely and respect fellow riders and the environment. For further information regarding the SVIA rider course, please call 1-800-447-4700. Do not drink and drive. It is illegal and dangerous.

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IMAGINATIVE ENGINEERING SHOULDN'T BE LEFT TO THE IMAGINATION.

FORD TAURUS.

In the development of a new automobile, it's unfortunate that some of the best ideas remain just that—ideas.

However, Ford has taken a different tack with their most innovative thoughts on automotive design.

They turned them into an automobile: Taurus. A benchmark of engineering excellence.

In fact, this is the second year in a row that Taurus has been selected as one of *Car and Driver* magazine's ten best cars.

The controls have been placed and shaped so your hands can find and identify them easily. And the seats were designed to provide maximum comfort and support.

Even the attractive Taurus shape is the result of careful thought. It's been designed to allow air moving over its surface to actually contribute to road stability.

Buckle up—Together we can save lives.

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And if you prefer the added feel of a 5-speed, Taurus offers the MT-5.

It's this kind of thinking that makes Taurus an automobile Ford simply couldn't leave to the imagination.

New 6-Year/60,000-Mile Powertrain Warranty.

Ford now covers all new 1987 cars with a 6-year/60,000-mile warranty on major powertrain components. Restrictions and deductible apply. New, longer corrosion warranty coverage for body panel rust-through is 6 years/100,000 miles. Also, participating Ford Dealers stand behind their customer paid work with a free Lifetime Service Guarantee. It's good for as long as you own your Ford car. Ask to see the limited warranty and the service guarantee when you visit your Ford Dealer.

Ford. Best-built American cars... six years running.

In fact, for the past six consecutive years, Ford quality has led all other American car companies. This is based on an average of owner-reported problems in the first three months of service on '86 models, and in a six-month period on '81-'85 models designed and built in North America.

Have you driven a Ford...lately?

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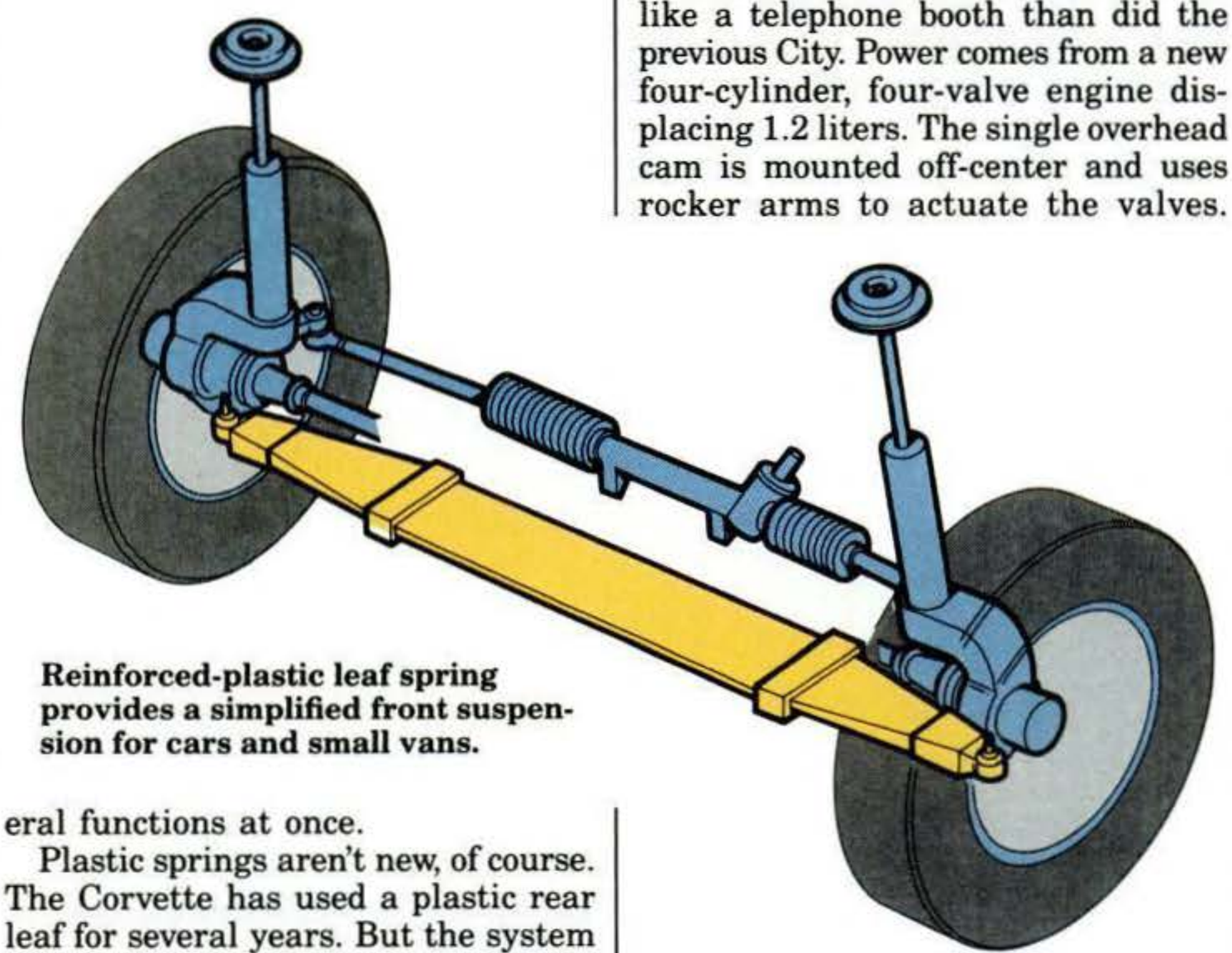
Honda's revised City could find its way into showrooms here in the U.S.

French venture has revived the transverse leaf spring, which has seen duty on millions of cars ranging from the Model T to the Yugo GV. But there's a difference. This time, the leaf is molded from reinforced plastic, a technique that allows it to perform several functions at once.



Reinforced-plastic leaf spring provides a simplified front suspension for cars and small vans.

Plastic springs aren't new, of course. The Corvette has used a plastic rear leaf for several years. But the system under development by GKN and Bertin allows one leaf spring to replace the coil springs, lower control arms, and front stabilizer bar of a typical MacPherson-strut design. The composite design of the spring allows separation of bump and roll stiffness, so handling can be optimized. Weight savings could be 60 percent compared with current designs.

GKN and Bertin, partners in the venture, say production of the system for cars and small vans may be five years away.

City traffic

Honda has unveiled an all-new version of its popular City subcompact for the Japanese market. Its 94.5-inch wheelbase is longer than that of the larger Civic three-door, and a lower roof line makes the car look a bit less like a telephone booth than did the previous City. Power comes from a new four-cylinder, four-valve engine displacing 1.2 liters. The single overhead cam is mounted off-center and uses rocker arms to actuate the valves. Aided by a computer-controlled carburetor, power output is 75 horsepower.

Later this year, the Civic will also be redone. Word is that the new Civic will be larger than the current model, and will be available with a 1.8-liter engine. Both changes would move it closer to the Accord. That could mean that the City will be brought stateside to fill the gap left as the Civic moves upmarket. PS

Contributors: David Scott (Europe), Kevin Radley (Japan), Tom Wilkinson (New York)

Baby your car with high tech.

Grandpa could break his arm cranking the family car if it kicked back, like a moody horse. Today that sounds like whimsy.

We motorists take for granted more and more high tech. Computerized dashboards tell you the miles to where you're headed. Cars can talk out loud, telling you when they need gas.

High tech extends to the things you feed your car, to give you more performance than ever before. You needn't change your oil every 500 miles, like Grandpa—with or without his arm in a sling.

That's because today's oils do more than just ease friction. Petroleum science provides ingredients performing a range of tasks: from stabilizing viscosity (flowability) over a wide span of temperatures—to soothing engine seals into fitting tighter and lasting longer.

You need today's high-tech oil for today's high-tech cars. Automakers give you more power from smaller engines—running them faster and hotter. Turbochargers give you an extra burst when you need it. Their impellers, cramming extra air into your engine, turn 2,000 times *per second*. Things get very hot, testing your oil.

For ease of mind and pocketbook, check your oil level every other time you buy gas. Your overall spring checkup obviously should pay close attention to your oil.

Most car owner manuals specify SF oil. "S," for spark combustion, designates an oil for a gasoline engine. F is the highest grade. "C," for combustion by compression, designates an oil for a diesel. D is the highest grade, mostly for big trucks. Some carmakers recommend SF-CC for gasoline engines because CC oil demonstrates special temperature stability around the pistons.

Most carmakers recommend 5W-30 viscosity for ideal conditions. "W" indicates rating at low temperature. So your high-tech oil lets you have it both ways: It's fluid at low temperatures, enabling easier starting in the cold—while retaining body at high temperatures.

Most high-tech of all: synthetic Mobil 1®, rated SF-CD. Here's why—conventionally refined engine oil is a mixture of thousands of hydrocarbons working together, more or less. In contrast, synthetic Mobil 1 is a unique combination of a few pure chemical building blocks selected just for their special lubricating capabilities. So it retains viscosity rating over a wider temperature range, and lubricates with less friction, contamination and wear.

That's man-made high tech outdoing nature.

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Champion — Obtain a $1.00 rebate (maximum) on the purchase of 4 or 6 or 8 Champion Spark Plugs (any type). Claim must include the number from package.

Anco — Obtain a $1.00 rebate for each purchase of Anco Refills, a pair of Anco Wiper Blades and a pair of Anco Winter Blades ($3.00 maximum). Claim must include the "Purchase Seal" from the Anco package.

Purolator — Obtain a $1.00 rebate with purchase of any Purolator Oil or Air Filter. Red and blue Purolator Signature from top flap of box must be included with claim.

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012	☐	Mobil Oil — $3.00 (5 Quarts Mobil 1) OR,	$1.50 or $3.00	
013	☐	Mobil Oil — $3.00 (12 Quarts Super or HD)		_____
021	☐	Glass Plus — $1.00 Any 22 oz. or Larger	$1.00 Rebate only	_____
031	☐	Purolator Oil Filter — $1.00 OR,	$1.00 Rebate only	_____
032	☐	Purolator Air Filter — $1.00		
041	☐	Champion Sparkplugs — $1.00 for 4 OR,		
042	☐	Champion Sparkplugs — $1.00 for 6 OR,	$1.00 Rebate only	_____
043	☐	Champion Sparkplugs — $1.00 for 8		
050	☐	Anco Refills — $1.00 AND	$1.00 Rebate only	_____
060	☐	Anco Pair of Wiper Blades — $1.00 AND	$1.00 Rebate only	_____
070	☐	Anco Pair of Winter Blades — $1.00	$1.00 Rebate only	_____
080	☐	Borden Rain Dance Liquid Car Wax — $2.00 AND	$2.00 Rebate only	_____
090	☐	Borden Rain Dance Paste Car Wax — $2.00	$2.00 Rebate only	_____
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Energy Q & A

By JAN F. KREIDER

Unfreezable solar heater?

Could a passive breadbox solar water heater be designed by the proper combination of insulation, size, etc., so that freezing would be impossible and it would not need to be drained in winter?

Frederick Butterfield
Williamstown, N.J.

Yes. A unit made by Solahart USA (3560 Dunhill St., San Diego, Calif. 92121) is guaranteed never to freeze at any site in the U.S. This is accomplished by using R-10 insulation, double glazing, and a selective surface for absorbing solar flux. This type of surface has very low heat loss by reradiation to the environment. The problem with these units in very cold climates is freeze-protecting the connecting plumbing: That becomes the weak point once the collector has been freeze-proofed.

DIY solar cell?

Can a simple photovoltaic solar cell be made in one's own shop?

D. S. Hatfield, Duluth, Minn.

Unfortunately, this is one solar system for which you cannot make the collector. Photovoltaic (PV) cells are semiconductor devices that require high-purity materials into which selected impurities are introduced to maximize efficiency. The equipment for this process is expensive and sophisticated. This is the basic reason that solar cells are quite costly today.

Vapor-barrier blunder?

I noticed several commercial office buildings being built in the Raleigh, N.C., area with the vapor barrier on the outside of the gypsum wallboard/insulation/metal-stud assembly. All of my schooling tells me that this is a big mistake. What do you think?

Jim Flythe, Raleigh, N.C.

In most of the U.S., you will find that local building practices dictate that the vapor barrier be on the inside of the wall system. In the humid Southeast, however, moisture will tend to flow from out of doors to the interior—the opposite of the northern U.S. In these southern climates, the vapor barrier should be placed as you saw it. Although you do have a heating season in Raleigh, the cooling season is longer. Some designers have recommended eliminating the vapor barrier altogether in mild, humid climates.

Photovoltaic info

I am interested in solar photovoltaics, inverters, etc. Where can I get a book on this subject?

Sid Stein, Sedona, Ariz.

A good introductory text without excessive technical detail is Photovoltaic Energy Systems *by Matthew Buresch (McGraw-Hill, 1983). You can order this book from any bookstore.*

Big enough duct?

I have replaced an oil-burning furnace with a new gas furnace rated at 165,000 Btu/h. Combustion air is to be supplied by ducts from the outdoors. The gas company has insisted on an eight-inch duct. Will this supply enough air?

O. L. Seng, Alliance, Neb.

An eight-inch duct (round or square) will not supply enough air for this furnace, according to the Uniform Mechanical Code, which is the mechanical code for many jurisdictions in the U.S. For ducts with horizontal runs, the UMC requires an area of one square inch for each 2,000 Btu/h of furnace input. For your unit, this translates into about 85 square inches. A round eight-inch-diameter duct has a flow area of about 50 square inches. You should recheck the duct size with your local utility.

Pool energy drain

I bought a home with a pool recently. So much energy is lost from the pool that the electric bill is larger than the mortgage payment. What can I do?

Weston Thorsen, Brookings, Ore.

First, stop heating your pool with the most expensive source of heat—electricity. Next, you should invest in an insulating pool cover. Most of the heat loss from a pool is from the upper surface by evaporation and convection. The cover reduces these losses markedly. One of the most abundant fuels in your part of Oregon is wood. Have you investigated the use of a wood boiler for pool heating? I doubt that solar heat would be feasible, but you might check with a local solar supplier.

Recycling roof heat

The roof and attic of my house become very hot in summer. Could I use a coil of ABS pipe on the roof to remove this solar heat to heat my pool? I plan to use a pump to raise water from the bottom of the pool to the collector on the roof. Will this work?

M. Newton, Mississauga, Ont.

This method of cooling your roof and heating your pool will work well—it is essentially the method used by commercial pool heaters, although the collector design is different. Your flow rate need not be excessive. Divide the cross-sectional area of your coil collector by 50 to find the recommended flow rate in Imperial gallons per minute. Keep in mind that you must remove water from this coil in winter to avoid freezing damage.

Solar-system air charge

My house came with a Revere solar hot-water system. It apparently needs an air charge to operate properly. Revere is no longer in the solar business. How can I find instructions for the system?

George Seeberg, Carson City, Nev.

If you can find the name of the installing firm on a decal somewhere on the system, call the company. Even though the company may no longer be installing solar systems, it may have access to information on your system. If this doesn't work, contact Revere directly at its Architectural Products Division (Box 151, Rome, N.Y. 13440). The Revere system is of standard design; any plumber who understands solar systems should be able to check the pressurization. All one needs is 20 to 30 psi in the collector loop to be certain the system is full.

Jan F. Kreider is a consulting engineer specializing in the design and economic analysis of energy-conservation systems. He is the author of several books on solar technology and a lecturer at the University of Colorado. Every other month he answers selected questions from readers about energy conservation or home heating and cooling. Send yours to Energy Questions, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Queries can't be answered by mail.

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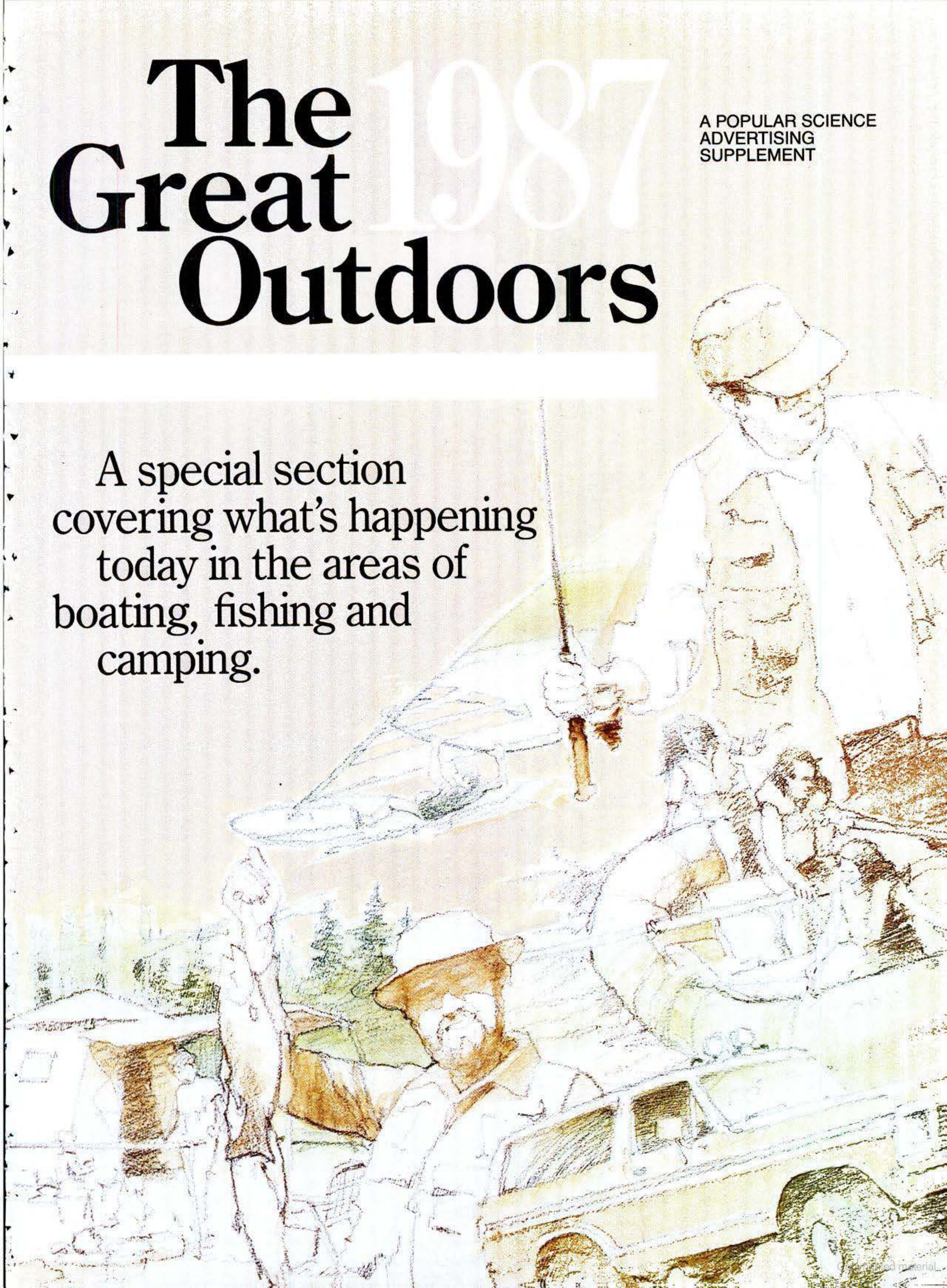
The Great Outdoors 1987

A POPULAR SCIENCE ADVERTISING SUPPLEMENT

A special section covering what's happening today in the areas of boating, fishing and camping.



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The Great 1987 Outdoors

What's happening today in the exciting world of boating, fishing, and camping

by Brook Elliott

Certain things just naturally pair up. Bacon and eggs; lox and bagels; ham and cheese.

Another natural pairing: Americans and the great outdoors!

The fact is, we are outdoor oriented. Americans spend more leisure time in the outdoors than any other people. We fish, we camp, and we hike the mountain trails. And we relate to water—whether it's rafting a white-water river, canoeing a placid stream, or cruising the Intercoastal Waterway.

"Americans spend more leisure time in the outdoors than any other people."

Why this fascination with the outdoors? Maybe it's because we are close enough to our pioneer roots to want to emulate our forebears. Or perhaps we are trying to recapture our childhood days, when a blanket over some kitchen chairs was "camping out." Or maybe, despite thousands of years of civilization, we have a primordial need to return to the caves and trees from which we started.

Psychologists may argue such points, but the real reason we do it is to relax—away from the pressures of

daily life. Nothing recharges the batteries like a day or a week spent outdoors, away from the routines of work and house care.

Of course, there are many outdoor pursuits. Fads come and go. One year it may be hot air ballooning; another year windsurfing is all the rage. The next fad is anybody's guess.

But the traditional outdoor pursuits of boating, fishing, and camping are always hot.

If you are an outdoor enthusiast, you're in good company. According to the National Marine Manufacturers Association, more than 67 million Americans participate in recreational boating. Indeed, the number of recreational boats owned has nearly doubled in the past 25 years.

What's more, 1985 saw more than 35 million fishing licenses sold (U.S. Dept. of the Interior figure).

Camping attracts new people every year. There's no better way to see our great country, especially as a family, than by camping. New destination camping resorts and transient campgrounds for tents, pop-up campers and motor coaches open every year. And millions of acres of public lands wait to be explored.

Escaping to the great outdoors can be as simple as slipping a candy bar in your pocket and pointing your nose at the forest. Or as complex as loading a megabuck motorhome with all the comforts and conveniences you can cram in. It can be paddling an inflatable boat across a farmpond, or powering a metalflake bass boat filled with electronic fishing aids across the thousands of acres of a TVA impoundment.

In the following pages, POPULAR SCIENCE's "The Great Outdoors—1987" will reflect some of the things I've seen and learned in my travels.

Whether you're new to the outdoors, or a seasoned vet, this special section is for you. In it, we'll do a little camping, and some fishing, and different kinds of boating. We'll look at some new equipment, and some older equipment you may not know about. And examine some of the products and techniques that make the outdoors safer, more convenient, and more enjoyable.

Brook Elliott's articles on boating, fishing, camping, and hunting have appeared in *Outdoor Life*, *Sports Afield*, and other national and regional outdoor publications. Together with his wife, Barbara—an outdoor writer herself—he travels over 30,000 miles annually to keep abreast of all that's new and exciting in outdoor recreation.

We'll watch the sun come up over a quiet backwater, and watch it set over the mountains. Catch a few fish, or maybe get skunked, but enjoy it just the same. We'll sit around camp at day's end, and dream by the fire for an hour or a century. And cruise a river by motor power and paddle power. We'll find some places to go, and provide tips on what to do when we get there.

Mostly, we'll have some fun in the great outdoors. Join us there! ■

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First time camping— tips to help you get started

Every year thousands of families decide to take up camping. It's an exciting, enjoyable way to explore the backroads, byways, and outdoors of America.

For many the decision is fraught with worry, because they think camping is complicated and uncomfortable. It doesn't have to be. The folks at Kampgrounds of America (KOA) have prepared a handy checklist for first-timers. Experienced campers may find it useful, too.

First, try a brief camping trip at a nearby campground. Borrow or rent equipment; don't buy until you've decided that camping is for you. If it turns out that it is not your family's thing, you won't have invested much.

What should you take with you? At a minimum, include:

• A water-repellent, family-size tent. Be sure it is easy to set up. Some tents would baffle the engineers who designed them. Set up the tent a few times in your backyard before leaving on your trip to make sure you know how, and that no parts are missing.

• A plastic ground cloth to be placed under the tent for extra protection against moisture. Even tents with built-in floors can use this extra moisture barrier.

• Sleeping bags for each family member. If you're traveling only during warm months, an inexpensive summer-weight bag will suffice. For four-season camping, better quality bags will be needed. Should you want to zip bags together, make certain you get one left-hand and one right-hand model for that purpose.

• Foam pads or air mattresses. Air mattresses are comfortable, but they can be punctured. If you get foam mattresses, be sure they are the waterproof, closed-cell kind or they will absorb moisture.

• Two-burner camp stove and lantern. These two items are available for use with either liquid fuel or propane gas. Although more expensive, the propane equipment generally is safer and easier to use.

• Camp kit of kitchenware. These kits, which include settings for two, four, or six people, fit neatly together for easy carrying. Kitchenware with "no-stick" coatings is easier to clean.

• A cooler. Do not get the largest available. Two 50-quart coolers will store your food and beverages more conveniently, and are easier to carry than one 100-quart version.

• Work gloves. They protect your hands when you're setting up the tent or cooking over the campfire.

• A first-aid kit and sewing kit for emergencies.

First-time family campers should remember that Mom needs a vacation, too. Don't leave all of the chores to her or you won't see a second camping trip.

Dads and kids should jump right in; don't just help. Give Mom a complete break. Organize the trip as though she weren't coming along. Make a list of supplies, including clothing for everybody. Do the shopping and packing, keeping items you will need first close at hand. Keep water, snacks, and things to entertain smaller children readily available.

Need more information on camping destinations? The following can help:

• Kampgrounds of America, P.O. Box 30588, Billings, MT 59114, has more than 700 campgrounds in its system throughout the United States and Canada.

• National Park Service, Office of Public Inquiries, 18th & C Street NW, Washington, DC 20240, operates campgrounds in National Parks and offers booklets about them and the parks, too.

• National Campground Owners Association, 804 D Street NE, Washington, DC 20002, is an organization of private campground owners in the U.S.

• Tourism Canada, 235 Queens Street, Ottawa, ONT K1A OH6, has up-to-date information on camping in every Canadian province.

• American Automobile Association, 8111 Gatehouse Road, Falls Church, VA 22047, has a variety of benefits and services for its members, including campground guides and directories. ■

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See America's wonders from a basecamp

Millions of American families take camping vacations every year. Other families are new to camping, having spent their vacations in the past at hotels, resorts, and lodges.

No matter which group you fall into, you may be surprised at the luxury available to today's camping family. Whether your preference is a cabin tent or a motorhome, there's no need to rough it. Today's private campgrounds (and many public ones, too) offer all the conveniences and comforts of a resort: electricity, running water, showers, and recreational facilities.

In the past, campground touring was popular. To some degree it still is, with many camping families driving from place to place, staying at a new campground each evening. This can be a great way to see the country. But it doesn't let you take full advantage of the amenities offered.

That may explain why, according to a study done for Kampgrounds of America (KOA), "base camping"—settling in at one campsite where there are many nearby attractions, and day touring—is becoming increasingly popular.

Whatever your style, campgrounds are so widely spread across the continent that the opportunities to see North America while travel camping are virtually endless. KOA is the largest system of private campgrounds open to the public, and probably has a facility near any place you are likely to visit.

Quiet beaches and ocean sports? Check out the KOA at Cape Hatterras National Seashore. Mountains? There's easy access to the Ozark Wilderness from the KOA at Osage Beach, Missouri.

Maybe food adventuring is your idea of vacation heaven. If so, try Basque cuisine near the KOA in Alturas, California, lobster at the Charlottetown KOA on Prince Edward Island, or Cajun cooking from any of six KOAs in Louisiana.

KOAs can be found in metropolitan areas as well as in the country. You can base camp at a KOA next to Disneyland in Anaheim, or Disney World in Orlando; tour Opryland from the Nashville KOA; see the strip in Las Vegas from a shuttle bus service provided by the North Las Vegas KOA, or explore the Washington-Baltimore corridor from either of two KOAs.

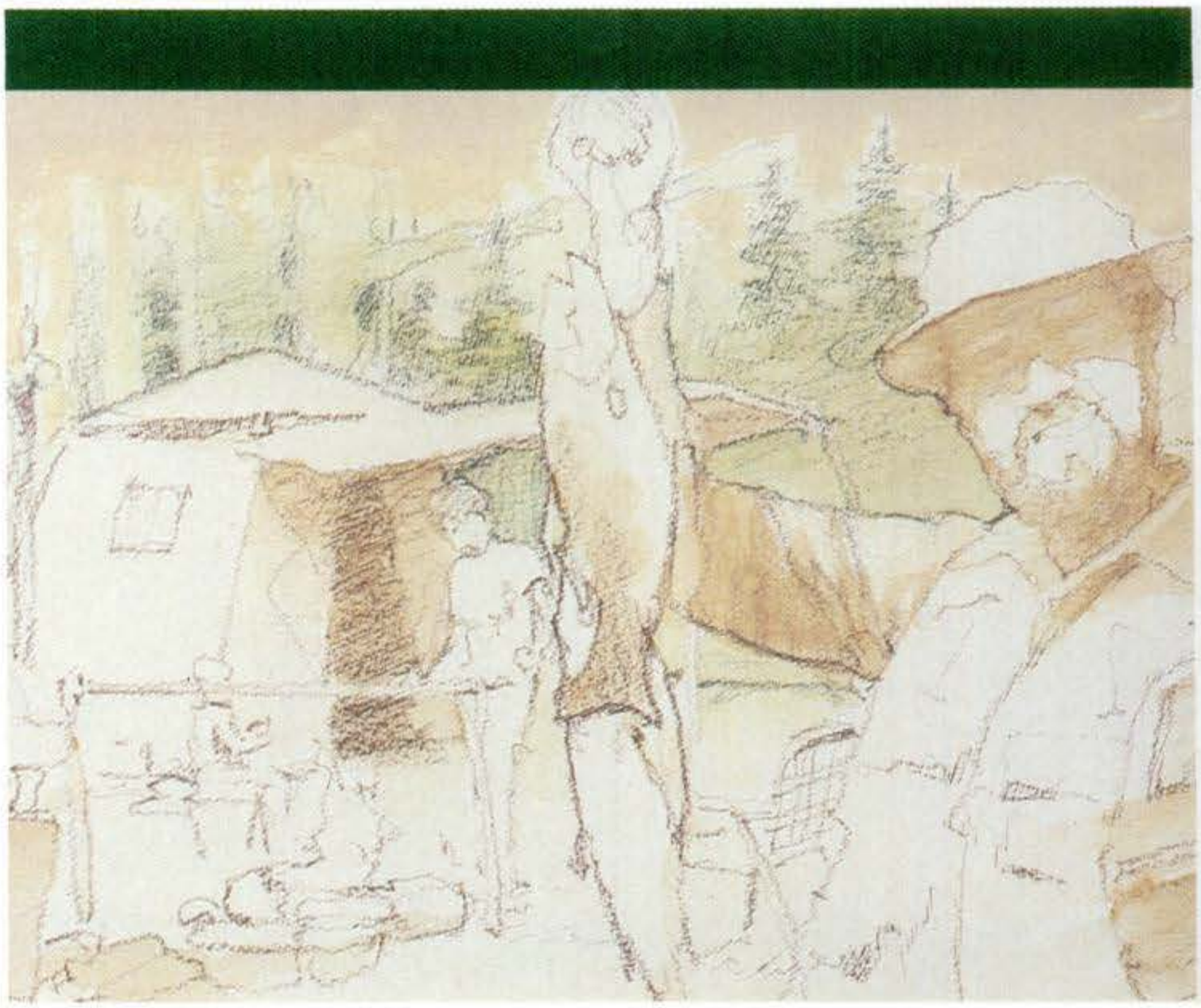
> "...the opportunities to see North America while travel camping are virtually endless."

Can't quite make up your mind where you might like to base camp this summer? Then browse through the four-color map section of the KOA Directory, Road Atlas and Camping Guide. It's available for $2 from Kampgrounds of America, Dept. PS, P.O. Box 30162, Billings, MT 59114.

Searching for the right area and campground should be a family activity. Here are some tips to make it easier:

- For peak periods or for certain summer attractions, long-range planning is a must. Public campgrounds inside National and State parks will require reservations. To avoid the crowds, choose a private campground near the attraction you want to see.
- When using a directory to pick a campground, consider the level of your camping skills, how rustic you want accommodations to be, and the type of vehicle you'll be driving. If it's a motorhome, make sure the necessary hookups are available. If you use your family car, be certain that tent sites or covered shelter is available.
- Ask yourself questions like: Do I want to gather wood and fuss with a campfire, or would I prefer ready-made firepits, stone ovens or barbecue grills? Will the kids want a place to swim, a playground, or want to buy an after-supper snack? Do I need hot showers and laundry facilities?

Campgrounds such as KOA offer these conveniences as a matter of course. If you can do without them, a rustic site in a National forest will suit your needs. But if your family wants comfort, maybe a private resort campground should be on your agenda as you travel camp the country. ■



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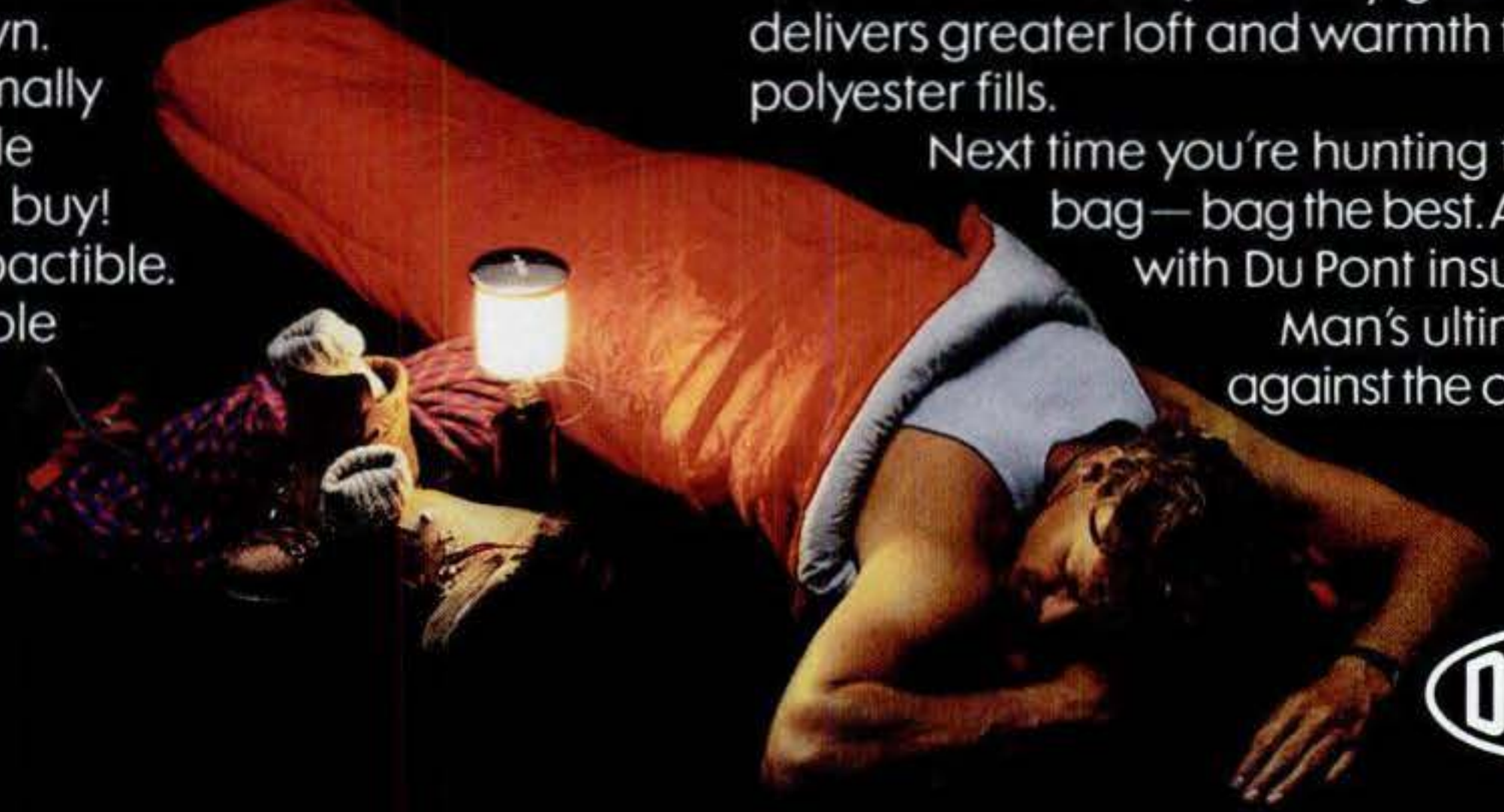

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Pack on the light side

You've spent months looking at RVs. Finally, you've found the one that's just right for you—enough beds, a kitchen, and a washroom like home.

Or maybe it's a pop-up unit—easy to tow, ample room once it's set up, and not too much effect on gas mileage.

Somehow, though, that recreational vehicle that seemed so spacious in the dealer's showroom can often shrink to miniscule proportions in the campground. A shortage of space makes everyone grumpy and short-tempered.

Coleman Company has been coping with this problem for more than twenty years, constantly coming out with pop-up trailer designs that expand storage space and roominess. The company's engineers offer a few tips to further help maintain family tranquility. Whether you use a fold-down camping trailer, a sophisticated motorhome, or the family station wagon and a cabin tent on your camping trip, their pointers are worthwhile.

• Keep meal preparation simple. Your built-in stove, sink, and water supply—or a portable Coleman stove and cooler—give you a compact galley. Choose smaller utensils than you use at home, because they stow more easily. Electric hookups in camp mean you can use small appliances. Nesting pots and pans help achieve neat stowage in limited space.

• Plan to stop along the way. Keep one or two day's supply of food on hand, and stop at roadside stands or small-town stores. You'll get the feel of the community and enjoy talking to store clerks who can tell you about local events and places to visit. You'll return home with bits of local history to help you remember where you've been.

• Use soft luggage. A duffle bag for each person makes it easier to keep track of possessions, and see-through plastic bags further separate items and make them simple to find. They pack easily in trailer or car. If a wardrobe rack isn't standard on your camping trailer, you may be able to add one as an accessory.

• Check campground and dealer stores. Items that make camp life easier are often found in campground stores or at your camping trailer dealer's store. Also check catalogs such as those issued by Camping World in Bowling Green, Kentucky. They specialize in compact items just right for small spaces.

• Wash clothes along the way. Take fewer clothes and plan to stop at city laundromats or use the campground facilities. Once again you'll rub elbows with local people and fellow campers.

• Use sleeping bags for bedding. They roll up out of the way during the daytime, can be aired out each morning, and are easily washed at the end of the trip in oversized commercial machines.

• Use a canopy or add-a-room. Especially important if you camp for a week or more in one place, a canopy, screen room, or a free-standing screened dining tent will expand your living space and protect you from insects and the elements. It's like putting an addition on your house.

• Plan for rainy days. Keep a favorite game, hobby items, or books in your storage areas. If family members are enjoying a table game, they're not so likely to chafe when confined to quarters. If that fails, pile into the car and visit a museum or library.

Camping vehicle quarters may be small. But don't forget that you have the whole outdoors to explore for many days. Make use of all that space in the green world. ■

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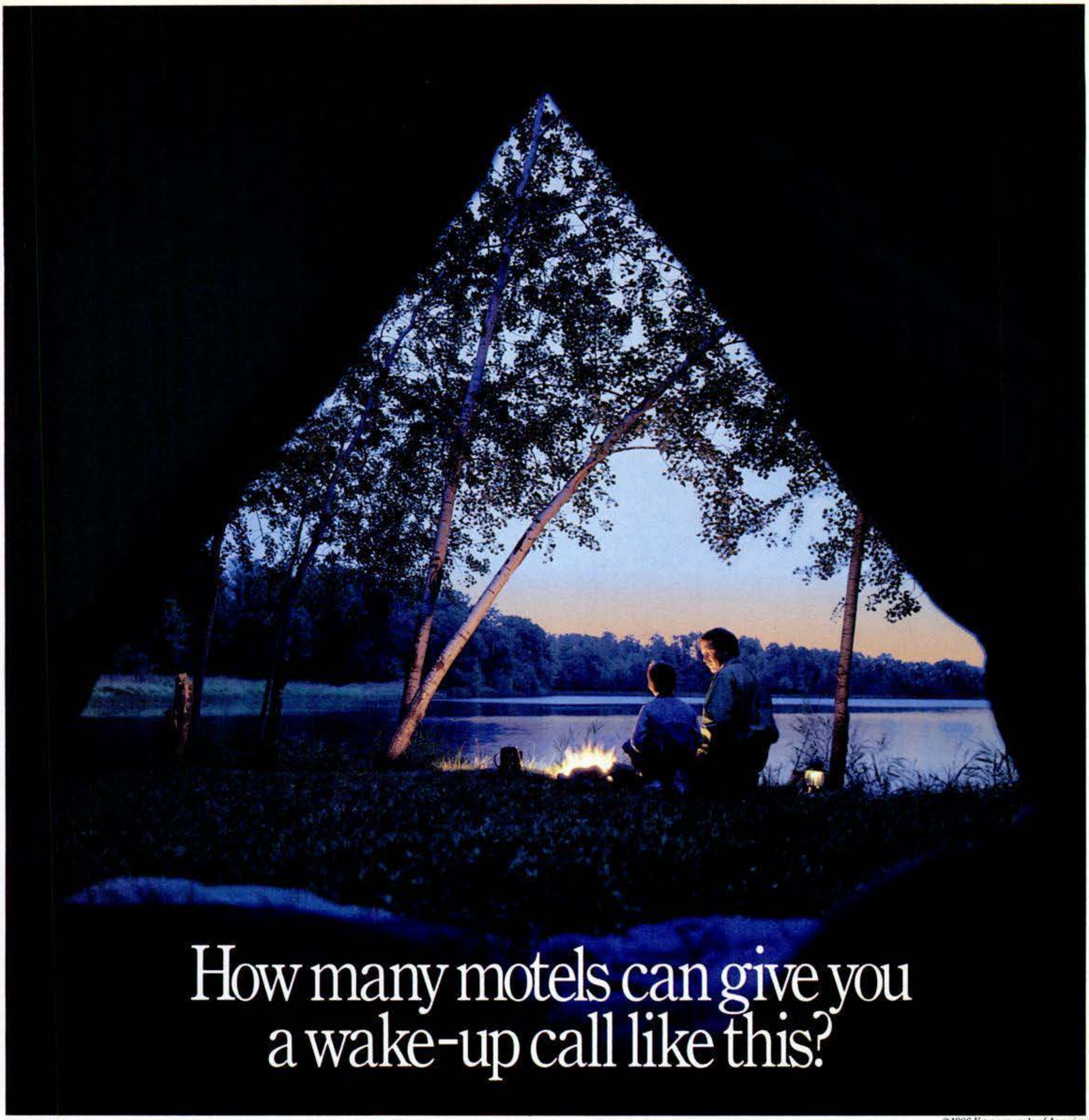

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A morning call from the Great Outdoors sure beats one from some anonymous operator, doesn't it? But that's just one of the things that make KOA a better place to check in to than a motel.

You see, staying at a KOA Kampground is not only more enjoyable than a motel, it's a lot more affordable. And with nearly 700 Kampgrounds all across North America, we're a handy place to stay on your way to most anywhere.

Why not take your family on a KOA vacation for a change? We promise you hot showers, clean restrooms, laundry facilities, swimming, a convenience store and more. We promise you the kind of good time you just can't get at a motel.

For your own KOA Directory, Road Atlas, and Camping Guide, send $2.00 to KOA Directory, P.O. Box 30162-PS, Billings, MT 59107.

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A great place to check in to!

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Recreational vehicles—camping first class

I used to sneer at motorhomes and megabuck camping trailers. "That's not camping," I thought, "it's taking your motel with you."

Frankly, I still don't call it camping. But I changed my mind a few years ago when I had the use of a 23-foot Shasta motorcoach. After putting 5,200 miles on the unit in a couple of months, I concluded that it still wasn't camping. But if you can, it's the only way to go.

Motorcoaching is ideal for a family on a budget. A study done by Pannell Kerr Forster for the Recreational Vehicle Industry Association compared vacation costs based on various modes of travel, ranging from cars and folding camping trailers up to air travel and hotels or motels. Costs were based on a family of four: two adults and two children, with one child under 12 and the other over 12.

Some of the results were surprising. For a two-night trip, the average cost using a car with folding camping trailer is $130 for the family of four. The same trip using air travel and hotels costs $808. In other words, using the family car and a pop-up camper, you could take a two-week vacation for the same cost as a weekend in hotels.

The same trip in a motorhome runs $158. With the family car and a travel trailer it costs $165.

RVing obviously is more expensive than traditional camping in a tent or pop-up camper. But it is more comfortable, too. That's important if you have family members who think sleeping without an electric blanket is roughing it. RVs come fully equipped with all the amenities of home, including real beds, showers and washrooms, furnaces, complete kitchens (including microwave ovens) and laundry centers.

As a report from the Go Camping America Committee points out, camping has traditionally been considered an activity for the young and hearty. But with the growing number of recreational vehicles entering the scene, camping has become one of the nation's favorite outdoor activities. Surpassed only by swimming and fishing, camping is now the third most popular participant sport in America among adults.

To accommodate campers of all ages and interests, campgrounds have changed significantly in recent years. They are increasing in size and providing more amenities than ever before. It is fairly common, for instance, for campgrounds like those in the KOA system to have stores, laundry rooms, recreation centers, shower facilities, movies, and swimming pools. Many campgrounds also offer extras such as on-site RV rentals, stocked fishing ponds, jogging trails, boat rentals, RV repair service, and even babysitting services.

The development of luxurious RV resorts, according to the Go Camping America Committee, is a new trend in camping. These offer such facilities as health clubs, hot tubs, outdoor and indoor swimming pools, tennis and racquetball courts, miniature and par-3 golf courses, and cable television hookups. Some even offer campers an opportunity to purchase an interest in the facility. There are about 450 of these RV resorts throughout the U.S.

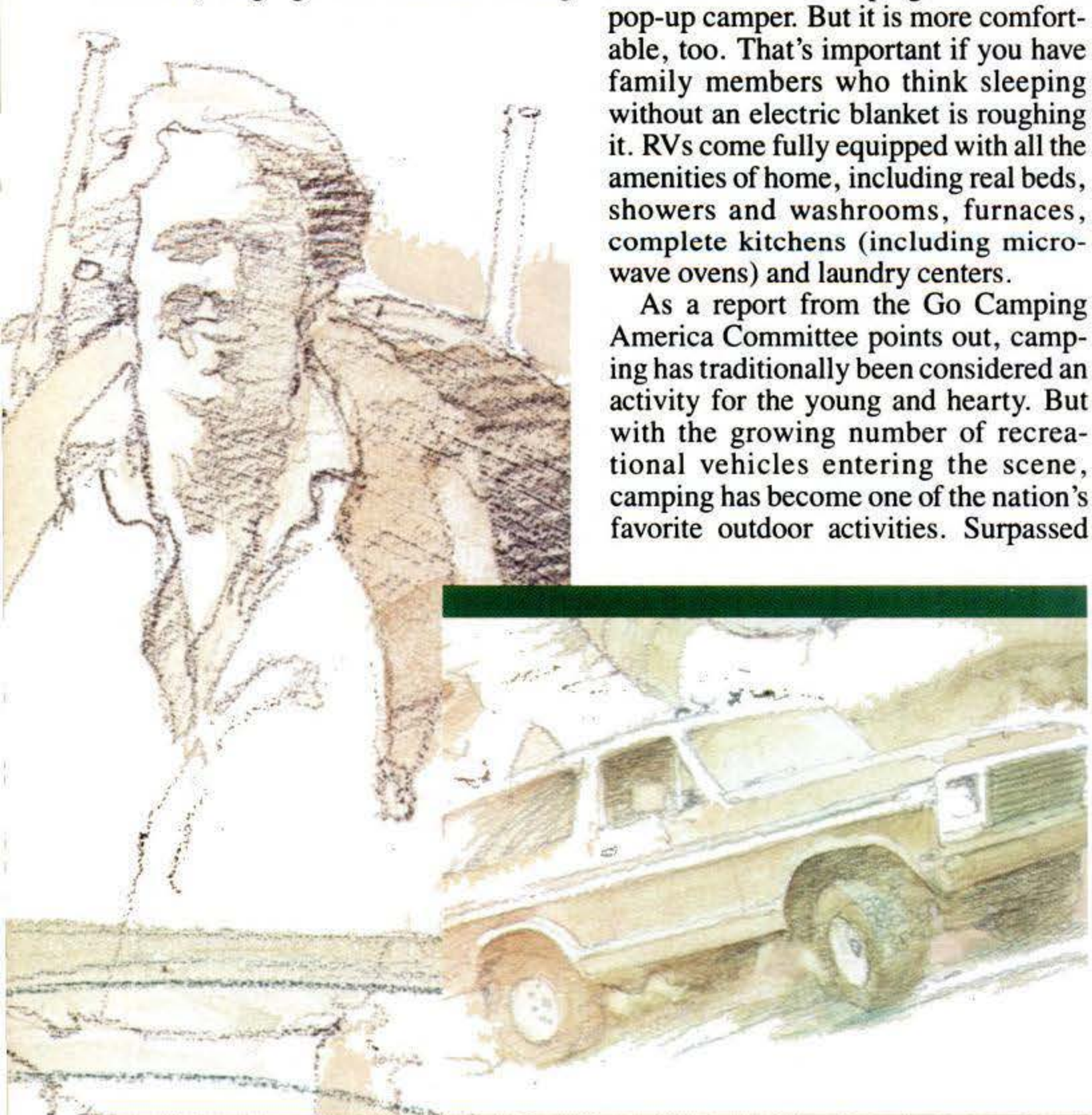
> "The development of luxurious RV resorts...is a new trend in camping."

Despite such luxuries, campgrounds are reasonably priced. The average daily cost of campsites in 104 cities, says Pannell Kerr Forster, was less than $11 in 1984, compared to $50 for hotel and motel rooms in those same cities.

Using motor homes is inexpensive. Purchasing them, however, is not. That Shasta we used carried a sticker price of $26,000 three years ago. Today you can buy a motorhome or travel trailer anywhere between $10,000 and $150,000.

Renting a motorhome

Instead, consider renting a motor-



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home the first few times you go RVing. Typical rentals run from about $150 a week for a pop-up trailer to as much as $1,000 a week for a fully-equipped 35-foot motorcoach.

At one time, there were about a half-dozen major RV rental companies. Most of them were single-location companies, and you had to pick up and return the unit there. U-Haul got into the RV rental business a few years ago, however, and changed that. With its 1,150 rental locations throughout the U.S. and Canada, one-way rentals are now available from its fleet of 4,200 motorhomes.

Some campgrounds have on-site rentals as well. And many private owners rent their units when they're not using them.

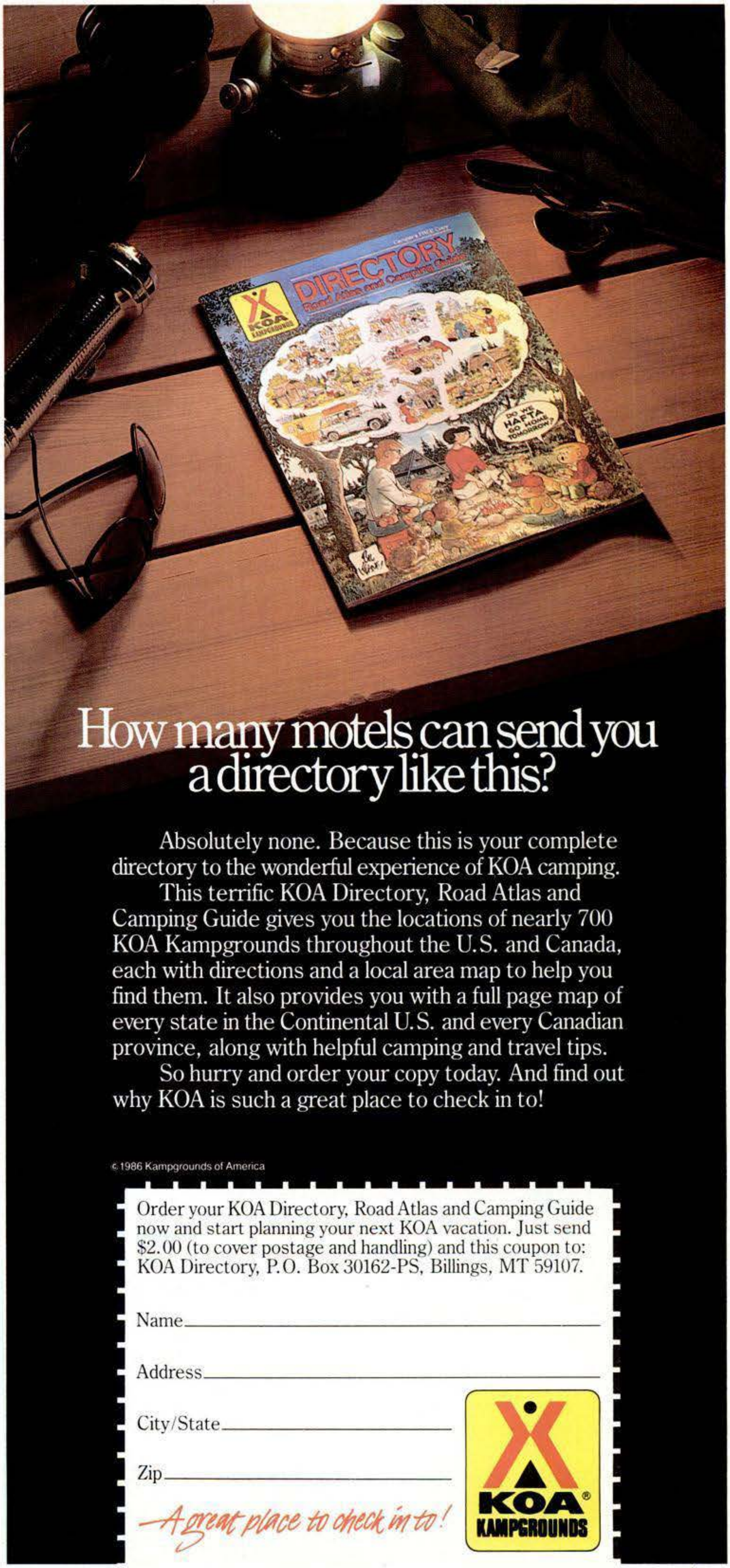
However, I recommend skipping the private rentals. You can't be sure of the mechanical condition of the unit, and there also may be insurance problems. What's more, private rentals are usually more expensive. For instance, I once inquired about a private lease on a 22-foot unit. The owner wanted $575 a week. That same unit from a company in the business, in better condition, was almost $200 a week cheaper. And it included insurance.

What about the on-site units? That depends. If you merely want to see how comfortable you'd be using one, and don't care about touring, they may be the answer. Rentals usually are priced a little less than a cabin or bungalow in the same area. And they're most likely equipped with everything you need except personal bedding and food.

Renting an RV from a leasing company is just like renting a car. There is a basic daily charge and a mileage charge as well. Insurance is included, except for a basic deductible which you can have covered for a slight additional fee. If you deal with a major RV renting firm, you'll be getting a late model unit that has been serviced regularly.

In short, renting an RV may be the best way to go. It will introduce you to the world of RVing, while providing the means to an affordable family vacation. And by renting different makes and models each time, you can develop a feel for what you and your family want in terms of floor plan, large appliances, and sleeping accommodations.

For more information about the RV lifestyle, contact the Go Camping America Committee, Dept. PS, P.O. Box 2669, Reston, VA 22090. ■



How many motels can send you a directory like this?

Absolutely none. Because this is your complete directory to the wonderful experience of KOA camping.

This terrific KOA Directory, Road Atlas and Camping Guide gives you the locations of nearly 700 KOA Kampgrounds throughout the U.S. and Canada, each with directions and a local area map to help you find them. It also provides you with a full page map of every state in the Continental U.S. and every Canadian province, along with helpful camping and travel tips.

So hurry and order your copy today. And find out why KOA is such a great place to check in to!

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Order your KOA Directory, Road Atlas and Camping Guide now and start planning your next KOA vacation. Just send $2.00 (to cover postage and handling) and this coupon to: KOA Directory, P.O. Box 30162-PS, Billings, MT 59107.

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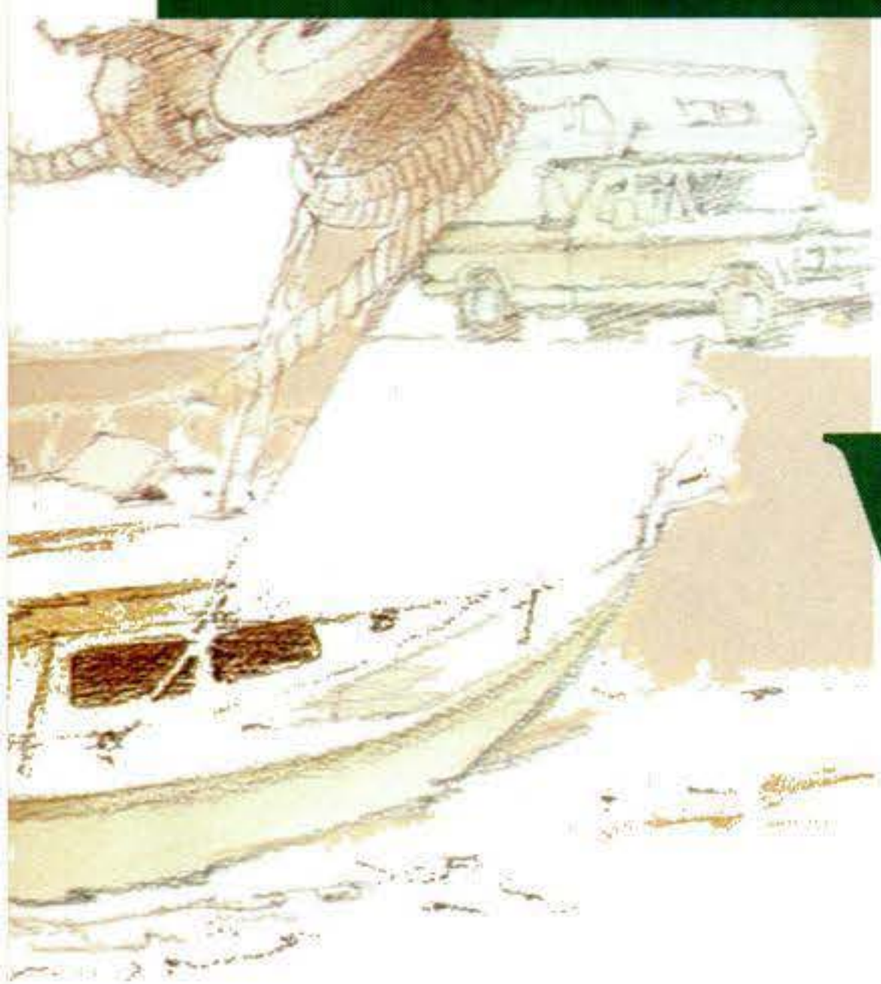

Plan ahead for rough waters—handling your boat in emergencies

What do outdoor enthusiasts and good scotch whiskey have in common? They both go well with water!

Nothing helps you enjoy the outdoors more than a boat. But throw in an unexpected dose of bad weather, or equipment failure when the waves grow tall, and a dream day on the lake can turn into a nightmare.

According to the folks at Yamaha Outboards, though, prior planning can help eliminate most of the risks of fishing and boating. Check weather forecasts prior to making a trip. Keep alert for unexpected changes, and allow enough time to reach a safe port or moorage before being caught in a storm.

Make sure your engine, fuel system, battery, and all mechanical connections are in tip-top condition before venturing out on the water.

Even so, accidents can happen, and if you get into trouble, you should know what to do. Handling your boat in rough water requires different techniques than when the lake is calm. Wind and wave action can combine to turn the most placid lake into a raging sea. Proper boat handling under these conditions is essential to reaching the dock without swamping. Keep a cool head, though, and you should come

HOW A SERIOUS DRIVER

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through fine.

You and your passengers should be wearing personal flotation devices at all times. Assign passengers positions in the boat that will balance the load, and make certain they keep those positions.

Locate the nearest sheltered area and plot your best course to it. Often you may have to take a round-about course to keep waves from breaking over the side or the stern, but determination and a sure hand on the throttle will see you home.

"Make sure your engine, fuel system, battery, and all mechanical connections are in tip-top condition before venturing out on the water."

Fight the temptation to open the motor full, say the experts at Yamaha. Speed is your enemy when fighting rough conditions. Don't try to take the waves head-on, either. Instead, take a course by which you can quarter up and down the waves into the wind. Apply the throttle while going up a wave, then reduce the power when going down it. As your boat reaches the top, let the crest of the wave simply roll out from under you.

Any well-designed boat—be it a 16-foot Ranger bass boat or a 36-foot day cruiser—can take very rough waters under power. While they will all pitch and roll a bit, the stability of the design will keep everyone and everything safe and upright.

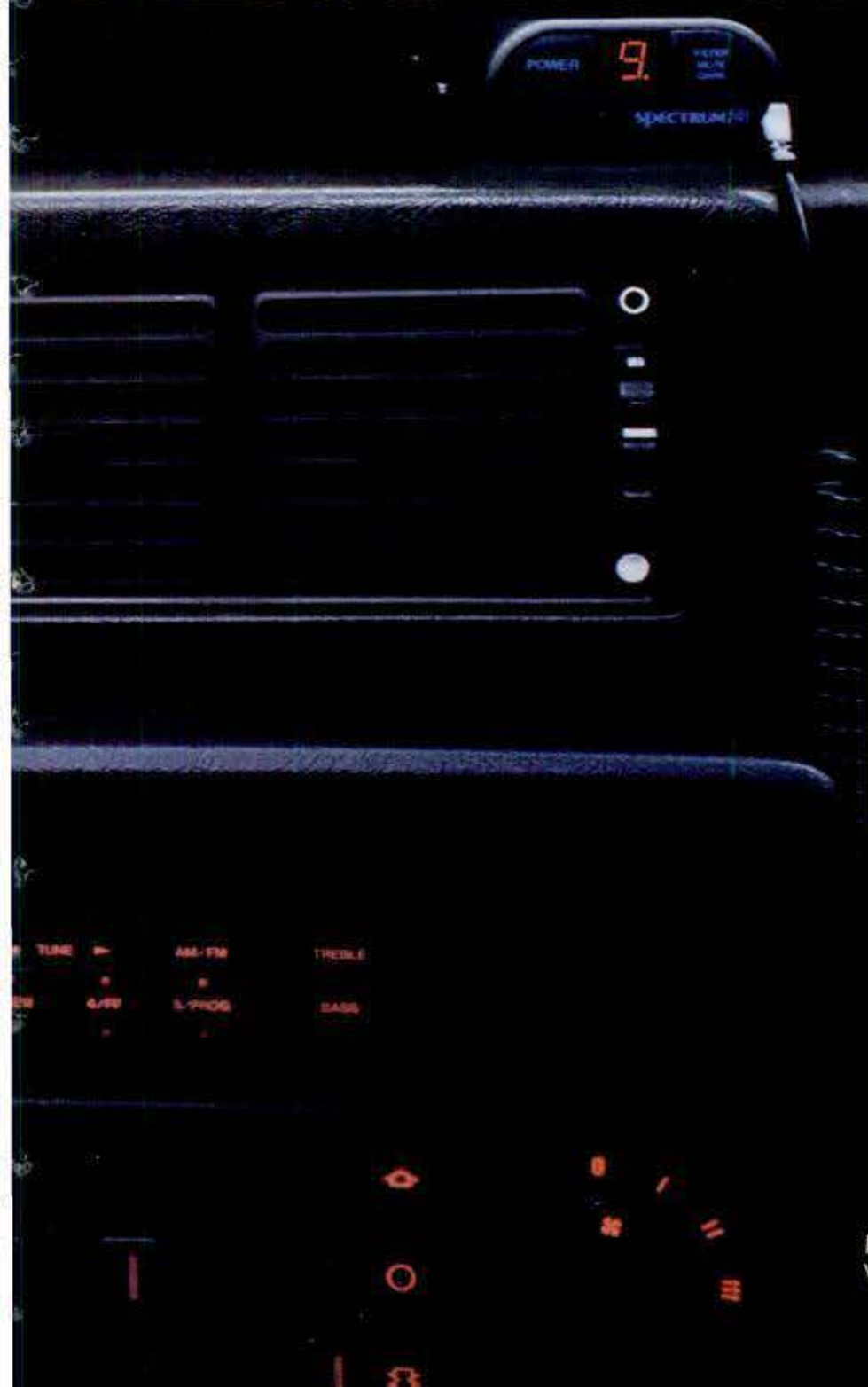
Never turn so a wave can strike the boat sideways or directly over the stern. Carefully observe the pattern and rhythm of the waves and make any downwind turn quickly in the trough between them.

Despite your best efforts, sometimes you may still swamp. If that happens, stay with the boat! Never, under any circumstances, leave the boat and attempt to swim to shore. Coast Guard requirements for boat manufacturers specify that a boat shall be designed so that, if swamped, it will still float level in the water. Ranger boats, for example, will float so that under normal conditions the occupants can remain seated in the swamped boat.

By all means try to reach shelter. Attempting to anchor in very rough water is tricky, and should not be attempted except in the most dire situation. If anchoring is necessary, use as long a rope as possible to insure that the anchor will hold, and the bow is not constantly jerked beneath the surface.

Use any signaling devices you have on board to summon help. Whistles, horns, and flares will attract attention from other boats and help will be on the way. ■

VIEWS THE WORLD.



To a serious driver, a car isn't just a means of transportation. It's a world where high technology is combined with an uncompromising sense of style to make driving more exhilirating, more satisfying, more fun.

Only one radar detector belongs in such a world: the Whistler Spectrum 2.®

Sleek. Black. Compact. Spectrum 2 makes ordinary radar detectors look sadly out of date.

Even more important, Spectrum 2 gives you the performance you demand. With unprecedented sensitivity, and advanced features like Whistler's Digital Display. All backed by our exclusive 3-year warranty.

And now there's Spectrum 2 Remote. It offers superior radar

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THE FIRST AND ONLY FUEL-INJECTED OUTBOARD.

You can choose from dozens of fuel-injected cars on the market. But there's only one fuel-injected outboard. Mercury's tradition of research and racing has produced a new engine for 1987 that is so technologically superior the competition may take years to catch up. In fact, the new Laser 220 XRi embodies a number of patented features that may prevent them from *ever* catching up. The Laser is 2.4 liters of fuel-injected V-6 performance with response so quick that, in a flash, the standards for outboard performance must be re-evaluated.

THE LASER THINKS FOR ITSELF SO YOU CAN KEEP YOUR MIND ON THE FUN.

Under the cowl is an Electronic Control Unit that precisely delivers fuel to each cylinder based on: engine speed, load, manifold pressure, air temperature and engine temperature. It even compensates for weather, altitude and low grade fuel.

FIVE MORE V-6's THAT HAVE EARNED THEIR STRIPES.

When you look at the Mercury 135 to 200, the first thing you notice is that they appear fast even when they're standing still. That's because all the Mercury V-6s have a 60° block instead of a 90,°as most competitors do.

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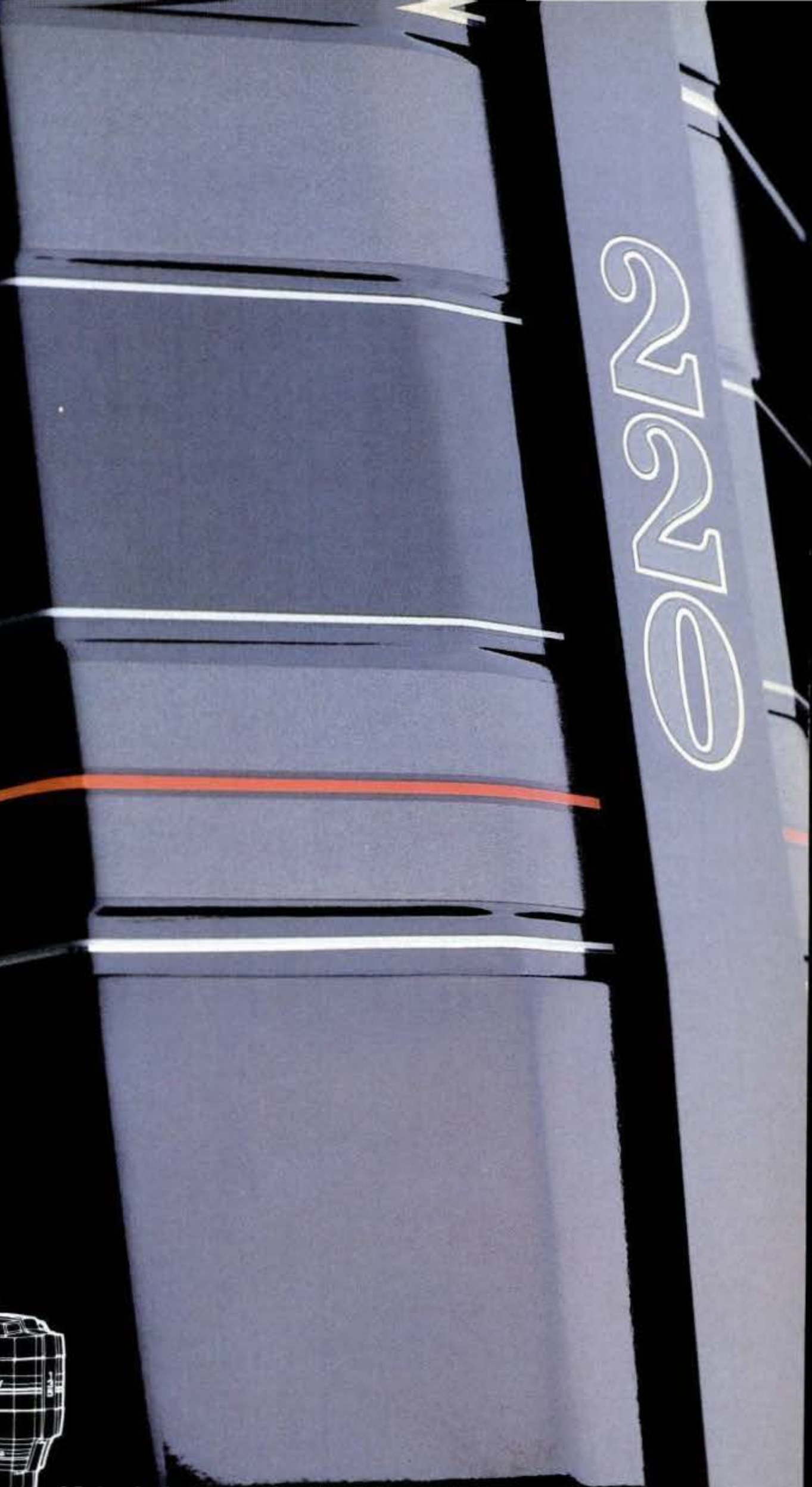
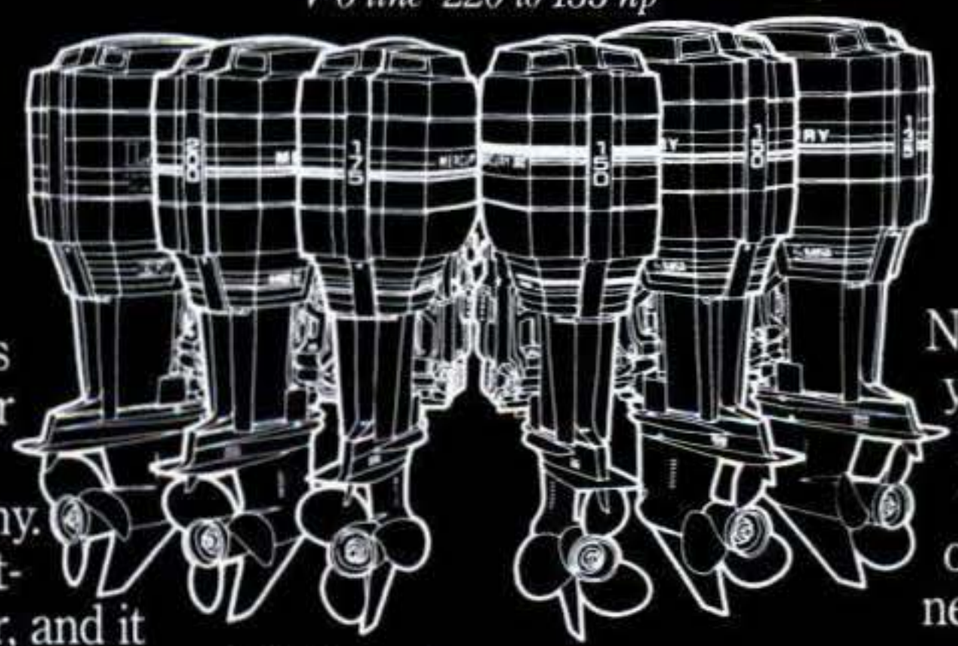
ER XRi



V-6 line 220 to 135 hp



That makes them lighter for better fuel economy. Dual mounting is easier, and it also makes for better visibility aft. And, when was the last time you saw a fast runner who was fat?

The Mercury 150XR2 has become almost part of the uniform for top professional bass fishermen...and still the one used most often by the pros.

Nobody beats you to the hot spots with one of these new Mercs.

THE MOST SEAWORTHY OUTBOARDS EVER MADE.

No other engines are made with Mercury's exclusive XK360 corrosion resistant aluminum alloy. No other uses as many high grade stainless steel components.

Or, the Merc 14 step coating process that includes on-line electrodeposition painting.

That's why no other outboard shrugs off salt like these Mercs.

Chances are, you didn't get where you are by moving slow, so why buy an outboard that moves that way? In the V-6 category, nobody even comes close.

MERCURY OUTBOARDS

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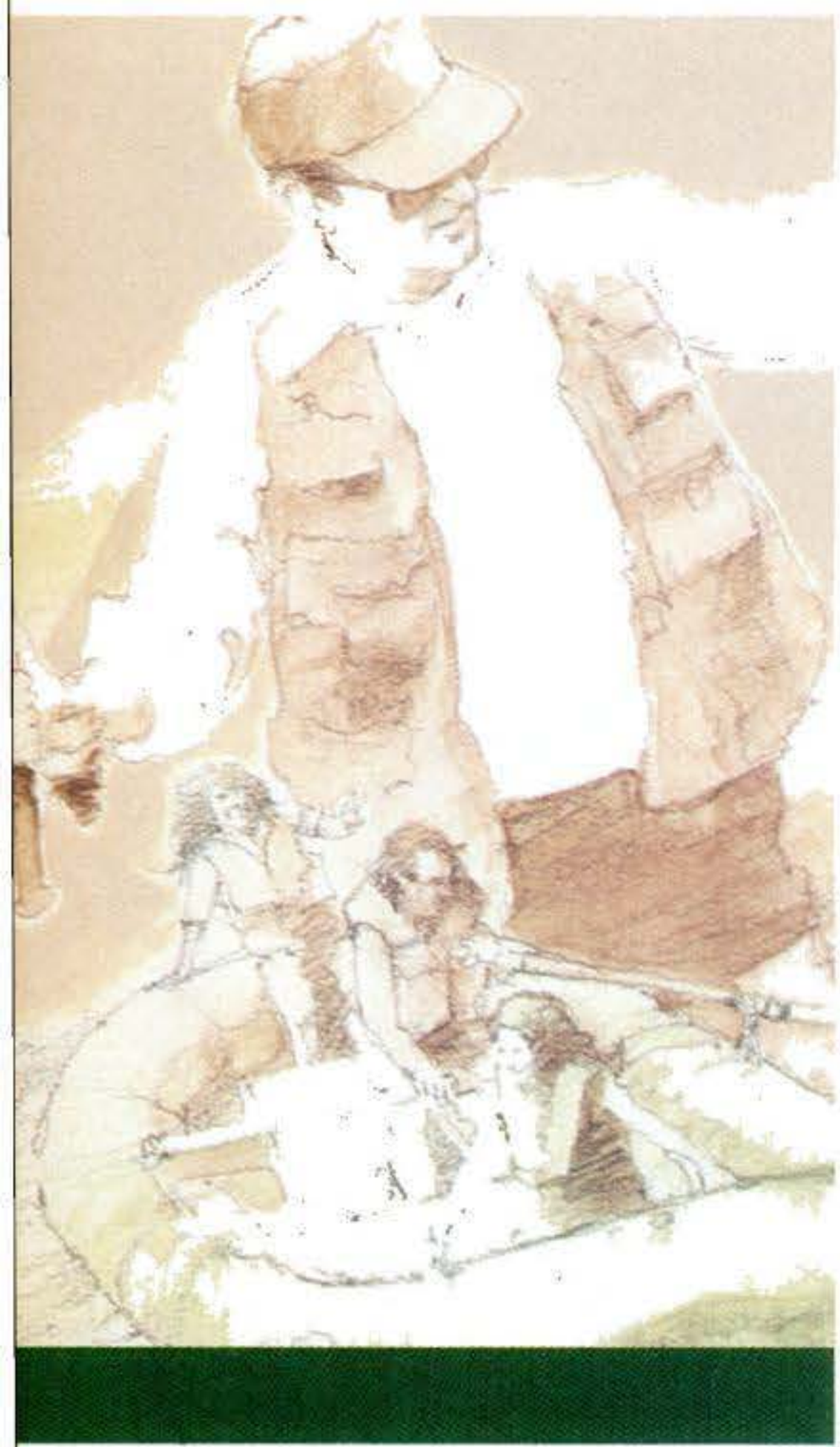
Good times in small packages—inflatables, folding boats, cartoppers

Look around the lakes and rivers and you'd almost believe that you could only go fishing with an expensive bass boat rigged out with the latest in fishing electronics.

Sure, bass boats, for those with the room to store them and the dollars to buy them, are a great way to go. The new Ranger and Stratos models, for instance, are the ultimate in fishing comfort and convenience. But they're not for everyone.

Actually, most fishermen use small boats. There are many reasons for this. First is cost. The average family man cannot justify spending $15,000 to $20,000 for a single-purpose craft like a bass boat. And even some of the newer bass/ski configurations, while useful for a number of watersports, carry too high a price tag.



Next is storage and handling convenience. Small boats are much easier to store in the garage or in that space next to the house than are big, trailerable ones. And if you choose an inflatable or a fold-up boat, storage and handling are even easier. Our Ally PakBoat, for example, folds to fit a carrying bag that can store in a closet. When assembled, it's a 16-foot canoe.

Finally, and to many anglers the most important is accessibility to fishing waters. The world is covered with small streams, ponds, and lakes which contain lots of fish. But there are no boat launches. Small cartoppers, inflatables, folding boats, and canoes can be carried to those waters easily. A larger boat would never make it.

How do you decide which small craft is right for you? That depends on where you're fishing, how you're getting there, the kind of storage space you have, and how much you are willing to spend.

You cannot make a decision unless you know what your choices are. And the local marina is unlikely to have more than one or two styles. Here's a look, then, at what's available in car-carryable craft:

Inflatable boats.

They're generally made of heavy-duty, tight weave nylon or similar fabrics. Dupont Hypalon and Trevira polyester seem to be the most favored materials. Most of the companies producing inflatables guarantee the fabric for five years, indicating that the boats are highly resistant to abrasions, punctures, chemicals, ultraviolet rays, and saltwater.

Inflatables come in all shapes and sizes from square rafts to canoes to deep-V boats. Most are chambered, so that a puncture or leak in one section will not collapse the entire craft. Many of them come with self-storing bags, and with their own pumps. Inflatables can be motorized. Most will handle only small outboards, like the Cruise 'N Carry, but others are capable of handling outboards up to 40 horsepower.

Are they reliable? Don't forget that the Navy seals use inflatables, as do other elite commando forces. Many of today's inflatable boats are built the same way, using the same materials, as the commando boats. The only difference is color. Some models you may want to look at:

> "Big boats needed for fishing? Not by a long shot."

• IMTRA manufactures inflatable dinghies under its Avon name. The company's duffle/kit bag will hold an 8 to 12-foot dinghy, hand and foot bellow, maintenance kit, and owner's manual. All of this weighs from 36 to 62 pounds, depending on the size of the dinghy. IMTRA recommends motors in the 3 to 6 horsepower range—such as those covered by Cruise 'N Carry and Tanaka.

• Novurania, on the other hand, recommends a 12 to 40 horsepower motor on its inflatable boats; check Mercury, Mariner, and Suzuki for them. Available in 8 to 13-foot lengths, the Novuranias come with floorboards, oars or paddles, repair kit, and foot pump, all stowed in a carry bag. Weights range between 81 and 200 pounds.

A recent development in inflatables is the float tube. Superficially they are all alike. A truck or aircraft-sized inner tube is contained in a form-fitting cover made of nylon. Pouches and pockets are included to hold fishing tackle.

The IDI Sports version is especially nice because the seat is reversible, giving you easier access to the pouches you use most, without having to twist around to reach them.

Continued

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Furuno's LE6000 LCD Fishfinder

The Big Picture

Furuno's big little LE6000, the only LCD fishfinder with a full 6″ vertical display that's up to 86% larger than other popular units, also has a super high resolution 160 × 63 pixel display where one dot on the screen equals just ¾″ in the water.

The LE6000 simply has all the features to provide a picture of the underwater world never before possible with an LCD fishfinder.

Powerful 800-watt transmitter; variable display advance rate; high efficiency transducer; anti-glare screen for easy reading. And optional sensors let the LE6000 continuously monitor boat speed and surface temperature.

Simple operation, dual alarms, tremendous resolution, Furuno reliability. The LE6000 gives you the big picture.

Send for complete information today.

Yes, I want to get the power of the LE6000. Please send information:

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Address _____

City _____ State _____ Zip _____

Type of boat owned _____

I fish ☐ freshwater ☐ saltwater ☐ both.

FURUNO U.S.A., INC.

Recreational Boating Products Division
P.O. Box 2343, South San Francisco, CA 94083
Furuno. The fisherman's best bet since 1947.

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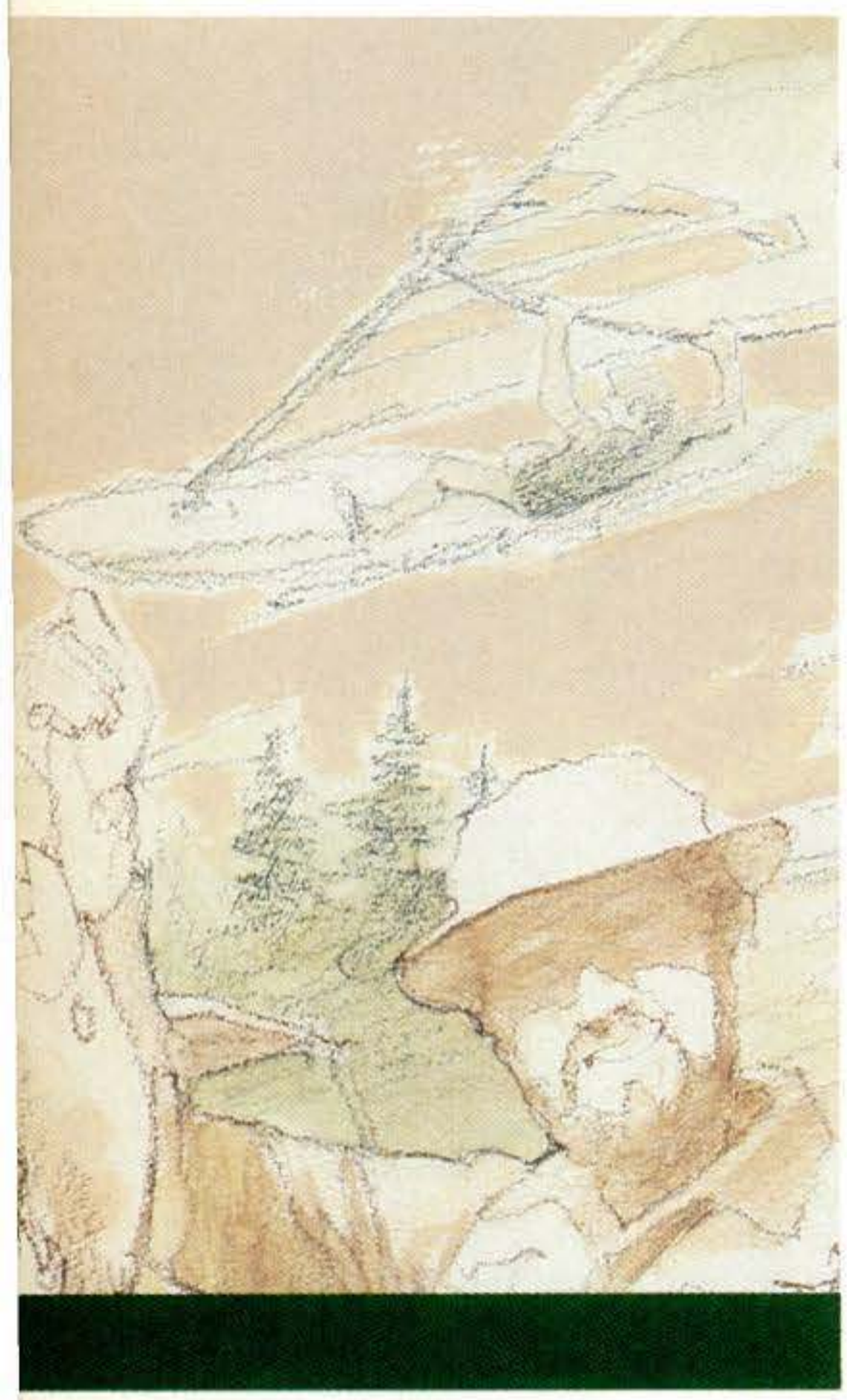


Usually used in conjunction with flippers, you sit in the tube and paddle it to where you want to fish. A simple tool, ideal for those small farm ponds and pocket waters you cannot reach any other way, as well as for river fishing when you don't want to cart around a bigger boat.

Folding boats.

As the name says, these boats are designed to be taken apart and folded into a neat package. Once assembled you have a 10-foot to a 17-foot craft.

Some, like the Ally PakBoat, come with an aluminum frame over which you stretch a PVC skin. We've been using one for quite some time, and find it convenient to store and assemble, but still a perfect canoe on the water. However, despite instructions, it is quite frustrating for one person to assemble. This is not the case with other similar craft. But the Ally's aluminum frame makes up for that one drawback.

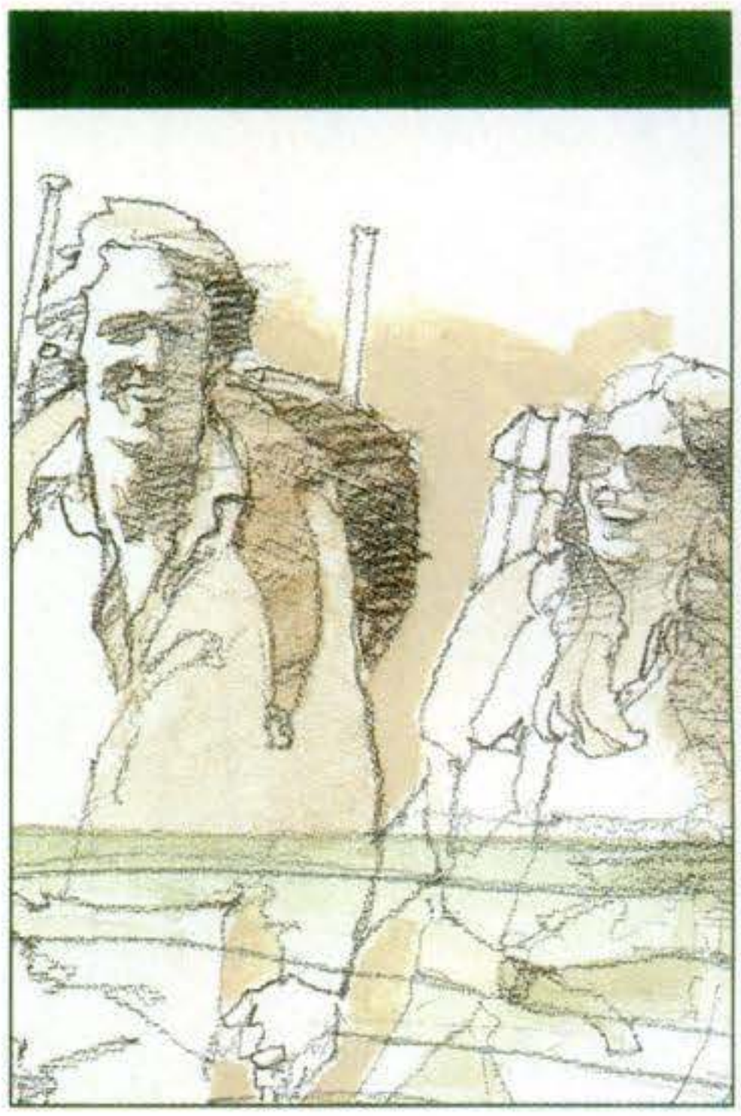
Other folding boats, like the Porta-Bote, literally fold into two halves. This polypropylene craft is available in lengths from 8 to 12 feet. When folded it is just four inches thick and can fit on top of most cars or be hung on the side of an RV. The Porta-Bote is rated for up to five horsepower, again making the Cruise 'N Carry or Tanaka ideal. Or you can use an electric trolling motor.

The Poly Tote Boat from Rotal International is the newest folding craft, and one of the most intriguing. This two-piece unit, when folded, becomes a 27 cubic-foot cartop carrier. At your destination, simply remove the craft from the top of your car, open it up, and you have a 10-foot polypropylene boat.

Cartoppers.

For those with more traditional tastes, there are still craft to reach those out-of-the-way fishing holes. Standard aluminum cartoppers, in both V-hull and John boat versions, fit the bill. These usually have a bow and stern bench seat, and an optional seat in the midsection. Oarlock sockets are basic. Other seats and storage compartments are available for many of these boats, too. Among the ones I've looked at:

- Grumman makes a 14-foot cartopper that will accommodate up to a 15-horsepower motor. At 135 pounds, the boat is easy to put on top of a car or slide into the bed of a pick-up.
- Lund's WC-12 aluminum V-hull weighs 154 pounds, is just under 12 feet long, and is rated for up to 15 horsepower.
- Alumacraft has both V-hulls and John boats for cartopping. The T-12 model V-hull weighs 115 pounds, is just under 12 feet, and is rated for 7½ hp. John boats are made in lengths from 10 to 14 feet, weight between 76 and 99 pounds and are rated from 1 to 7 horsepower.
- DuraCraft's Fisherman model V-hull weighs 137 pounds, and at 12 feet handles a five horsepower motor.



- Sea Nymph makes a Big Water model. At 175 pounds it's a bit on the heavy side. But it can handle up to 25 hp and carry as much as 830 pounds of fisherman and tackle.
- Coleman's Crawdad, made of molded Ram-X, might be the best cartopper of all. At 111 pounds and just over 11 feet, the boat can handle a five horsepower motor, and will mount a trolling motor on either bow or stern. Stowage bins and trays are molded in and the floor is decked for safety.

Big boats needed for fishing? Not by a long shot. There's a small craft made just for your needs. ■

For more information on many of the products mentioned in "The Great Outdoors —1987" please refer to the Product Information page (24dd).

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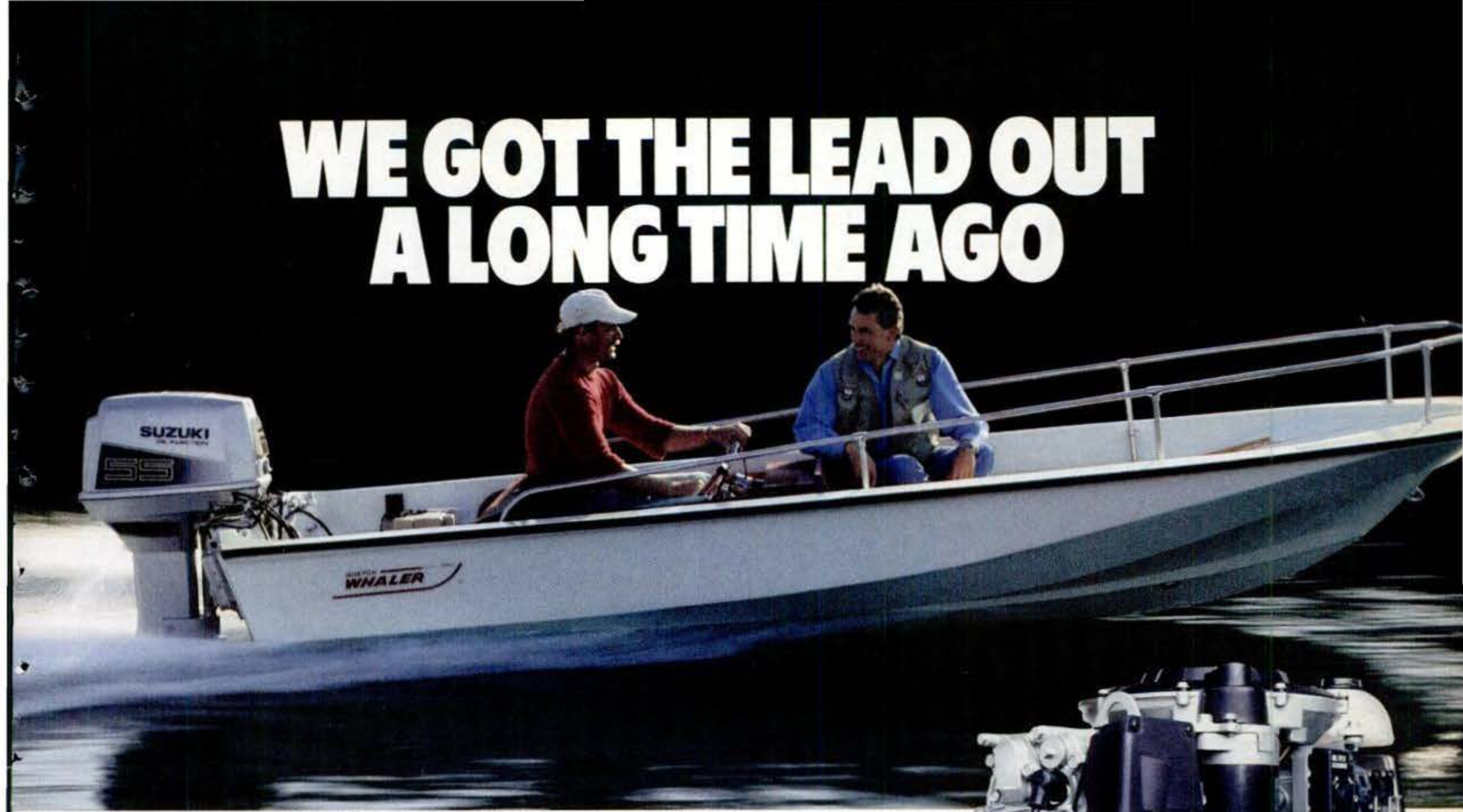
WE GOT THE LEAD OUT A LONG TIME AGO



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Give your outboard a Spring cleaning

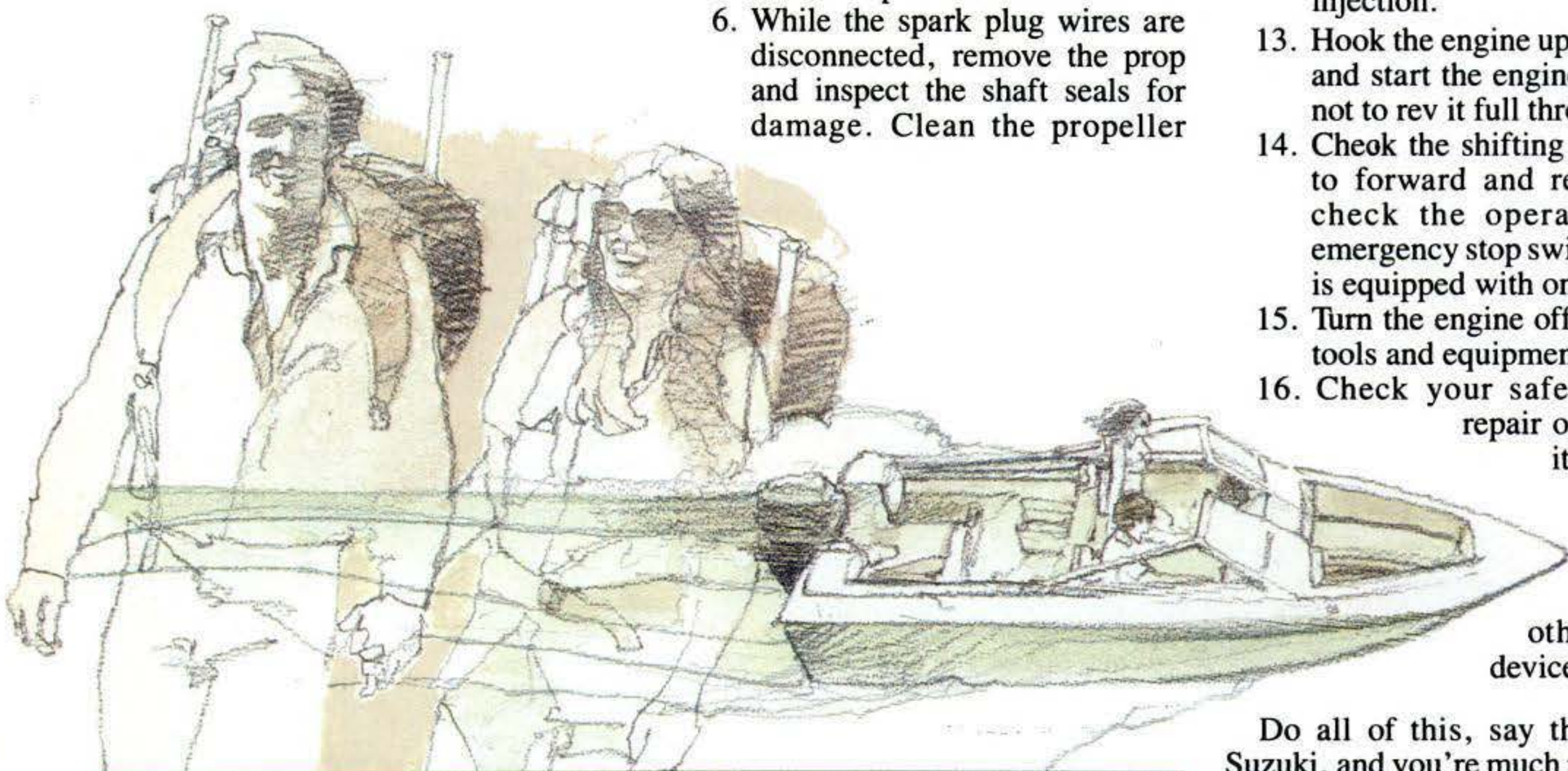
Just because you winterized your outboard when you stored it away last fall doesn't mean it's ready to go. There are steps to take now that will assure you of many pleasant boating hours this summer.

The following check list, prepared by the technical staff of Suzuki America, should be followed no matter which brand of outboard you own. It's an easy way to take your outboard out of its winter hibernation.

Before doing any work on the outboard, check your owner's manual for a list of the recommended lubricants. If you don't have an owner's manual, contact the manufacturer. Get the lubricants, a set of new spark plugs, and appropriate tools: a large screwdriver, spark plug gapping tool, and spark plug socket.

Park your boat in an area where you can work on it, or move the outboard storage rack to a roomy work area. Then you're ready to begin.

1. Tilt your motor down into the operating position.
2. Remove the battery, clean it and the battery cable connectors. Check the water level in the cells and top them off with distilled water. Then give the battery a good slow charge. Always wear protective goggles when working around batteries, and keep cigarettes, flames, and spark-producing objects away from the area.
3. Drain the gearlube from the lower unit into a suitable pan if it wasn't changed in the fall.
4. While the lower unit is draining, remove the motor cover and examine the powerhead for signs of leaking gaskets or seals and for chafed wiring. If there are any problems, see your local service center for repairs.
5. Remove the old spark plugs and discard. Set the gap on new plugs according to manufacturer's specs and install them. Before connecting the spark plug wires put a very small dab of marine grease on the terminals to prevent corrosion.
6. While the spark plug wires are disconnected, remove the prop and inspect the shaft seals for damage. Clean the propeller shaft and lubricate it with marine grease. Reinstall the prop and secure it with the proper washers and nuts, tightening to torque specifications. Replace all propeller nut locking devices such as cotter pins or tab washers with new ones to assure that the prop nut won't come loose.
7. Install the spark plug wires.
8. Lubricate all lube points noted in your manual. Always use the recommended lubricants.
9. Check all cables and steering parts for corrosion, for cracks in the cable coverings, and for sharp kinks in the cables. Remove any corrosion you find and lubricate the cables. If there are cracks or sharp kinks in the cables, have them inspected at a service center.
10. Refill the gearcase, using manufacturer-recommended gearlube. Fill it from the bottom to assure there are no air pockets. Make sure the drain plugs are securely tightened, and that seal washers are new or in good shape.
11. When the battery is fully charged, reinstall it. Be certain the battery cables are connected to the correct terminals, and that terminal nuts are tight.
12. Top off all fuel tanks with the correct fuel mixture, and top off the oil tank if the unit has oil injection.
13. Hook the engine up to a flushette and start the engine. Be careful not to rev it full throttle.
14. Check the shifting from neutral to forward and reverse. Also check the operation of the emergency stop switch if the unit is equipped with one.
15. Turn the engine off and stow all tools and equipment.
16. Check your safety gear and repair or replace any items that are broken or out-of-date (such as flares or other signaling devices).



Do all of this, say the experts at Suzuki, and you're much more likely to have a safe, trouble-free boating and fishing season. ■

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Here's a Tough, Small Outboard that Weighs 50% Less and is Priced up to 23% Lower than Alternative Motors.

If you're looking for a reliable small outboard motor to propel your inflatable, sailboat, fishing boat, dinghy, run-about or canoe – here are the three toughest, lightest and most affordable outboards today.

Because Cruise 'n Carry outboard motors use high performance components like, for instance, ball bearings around the crankshaft and needle bearings on the connecting rod which create extra long engine life, or like our new non-corrosive propeller, you'll find they are built especially tough, to give you years of dependable performance.

Cruise 'n Carry outboards are lightweight, in fact, the lightest at their horsepower levels due to our state-of-the-art designs and modern lightweight component materials, making them easy for you to use, carry, and store. . . and they're affordable, priced surprisingly lower than competitive motors, due to our large volume manufacturing techniques. . . all to help you afford them easier. That's why thousands of satisfied users call them the "lightweight champions."

Below you will find some highlights on the unique Cruise 'n Carry outboards which prove why you'll never again need another small outboard that weighs a ton or one that costs you an arm and a leg.

The Model 6800-6HP

This rugged new 6HP gives you all the power you paid for.

It's only 35 lbs. – making it the lightest in its class which allows your boat to move faster in the water. It has a carrying handle for easy handling too.

It's fully water cooled, with thermostat control, giving you efficient engine cooling.

The special solid state ignition gives you quick, reliable starts.

There's a forward-to-neutral gear shift that gives you better control and handling with no loss of power at the propeller.

The model 6800 will quickly swivel 360° allowing you unobstructed steering maneuverability.

The throttle handle rotates 180° making it easy for you to reverse direction.

The model 6800 also comes in a special long shaft sailboat version.

You'll find the model 6800 has lots of other outstanding features usually found only on larger horsepower outboards.

The Model 6700-2.7HP

This powerful 2.7HP motor has a positive-action gear shift that allows you to change from neutral to drive with a slight pull on the shift knob.

It weighs just 17 lbs., so that even the smallest sailor can carry it easily.

The model 6700 has a weight-to-horsepower ratio that delivers for you more thrust and power than engines that are as much as 50% heavier.

There's solid state ignition giving you easy and reliable starting.

The model 6700 has many other features that make it a top performance lightweight outboard.

The Model 6600-1.5HP

Here's a 12 lb. powerhouse that will out-perform outboards at twice the weight. At 12 lbs., you can move it on and off your bouncing boat with ease.

It has a positive-action gear shift allowing you to change from neutral to drive or back again with just a touch.

The model 6600 has many other large-motor features, such as solid state ignition, underwater exhaust, and many, many more.

How to Pick a Lightweight Champion

With the Cruise 'n Carry you'll get the lightest outboard available loaded with convenient features, that will give you years of dependable service...and at a price that's really lightweight, in fact, as much as 23% lighter in price. List price as of 1/87.

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Your home on the water—the joys of houseboating

Boating, camping, and fishing are the three most popular outdoor pursuits. Sometimes you combine them—maybe with an RV or tent in a lakeside campground and a canoe or fishing boat tied up nearby.

In many areas, you can combine them in another way: Houseboating. Rental houseboats are available at hundreds of marinas on many lakes, rivers, and impoundments, with more opening all the time.

Many rental houseboats are available on top fishing waters, too. For example, virtually every marina on Lake Barkley in Kentucky and Tennessee has at least three houseboats for rent and some have as many as fifteen.

From Minnesota to Texas, Massachusetts to California, houseboating has become very popular. And for good reason. It combines the best of outdoor vacationing at affordable rates.

For the fisherman, the benefits are obvious. No more long, predawn drives to the lake and an equally long boat ride to the fishing spot. Just anchor your home where you intend to fish, and when you get out of bed you're there.

Houseboating is something for the non-fisherman to consider, too. Imagine a lakefront cabin that's moveable. Every evening you anchor in a new cove, away from the bustle of the campground or cottage park. You discover unknown shorelines, camp on private sandbars, and explore serene coves and inlets.

I don't know anyone who has taken a houseboating trip who hasn't at least planned a second one. And that includes family groups, church and social organizations, and plain old hunting and fishing buddies.

Your first step should be to gather brochures from marinas and resorts. You can usually find them at travel and outdoor shows. Some states have listings, although they may be incomplete because of the high attrition rate among houseboat renters. Chambers of Commerce in water resort areas can help, too.

Here are some tips about houseboat renting from Michele Farmer of Leisure Cruise Marina on Lake Barkley (Box 266, Kuttawa, KY 42055).

First, you don't need previous boating experience. Every marina provides operating instructions including taking you out on the water to show you how everything works. "We actually prefer inexperienced people who are anxious to learn," says Michele, "rather than the experienced boater who thinks he knows everything."

Your rental houseboat will come complete with everything you need, including linens, bedding, utensils, stove, etc. You take personal items such as fishing tackle and binoculars. "Usually people bring too much, rather than too little," she says. "All the clothing you need are some shorts and swim suits, maybe long pants and a heavy shirt in case of cool weather."

Food and fuel are extra. Remember, however, you're food shopping at supermarket, not restaurant prices. Marinas may have items such as candy bars and canned foods, but fresh meat and produce are usually not available! Most people stock up at the local supermarket.

When you rent a boat, it comes with full fuel tanks. After that, you pay for additional fuel. But most people, according to Michele, don't do a great deal of cruising. "After the first five miles, everything looks the same. So most people set up housekeeping in a cove, and perhaps change locations only once or twice." As a result, the average houseboater doesn't use more than $50 worth of fuel in a week.

Power and water are another story. "Fresh water is limited, so we suggest being stingy with it. The renting marina will usually refill the tanks at no charge, but it requires a trip back to the dock." She recommends that washing be done in the lake, using bio-degradable soap, and that potable water be reserved for cooking and drinking.

Houseboats with generators have plenty of power. If you rent a boat with a generator, you'll probably have both air conditioning and heating. But those without generators cannot be used for AC appliances like toasters, microwaves and lights. "You can plug in dockside to run these items. The renting marina probably won't charge for hook ups, but if you pull into another marina, expect to pay for electricity."

How big a boat do you need? A family of four can use a 36-footer. Three couples, or two families will need something bigger for extra privacy. "There are boats that are supposed to accommodate 12 or more," Michele adds, "but I've never seen one that I would feel comfortable with more than 10 people aboard."

Rental costs vary considerably, based on size, age, whether the boat has a generator or not, and other amenities. A small boat with outboard motors may run $500 a week. On the other hand, a 50-footer with inboard motor, generator, and microwave oven might cost $1,500 or even more.

When you make a reservation, a deposit will be required. The marina operator will hold it as a security payment until you return the boat. The full cost of the rental will be due upon departure, and most marinas insist on cash, certified check, or travelers checks.

At most marinas there is a minimum rental period of three days. Although there are no maximums, few people take a boat for more than a week at a time unless they are truly avid boaters. You can find special deals, too, if you shop around.

If you have your own fishing or ski boat, don't hesitate to take it, as it can be towed behind the houseboat. "Although we don't require it because all of our boats have radios," says Michele, "some lakes and marinas require that you have a small motorized boat along—either your own or a rental. This is for emergencies. If someone is hurt or ill, you cannot travel fast in a houseboat."

To sum up, houseboating may be the ideal way for you and your family to enjoy the great outdoors this summer. ■

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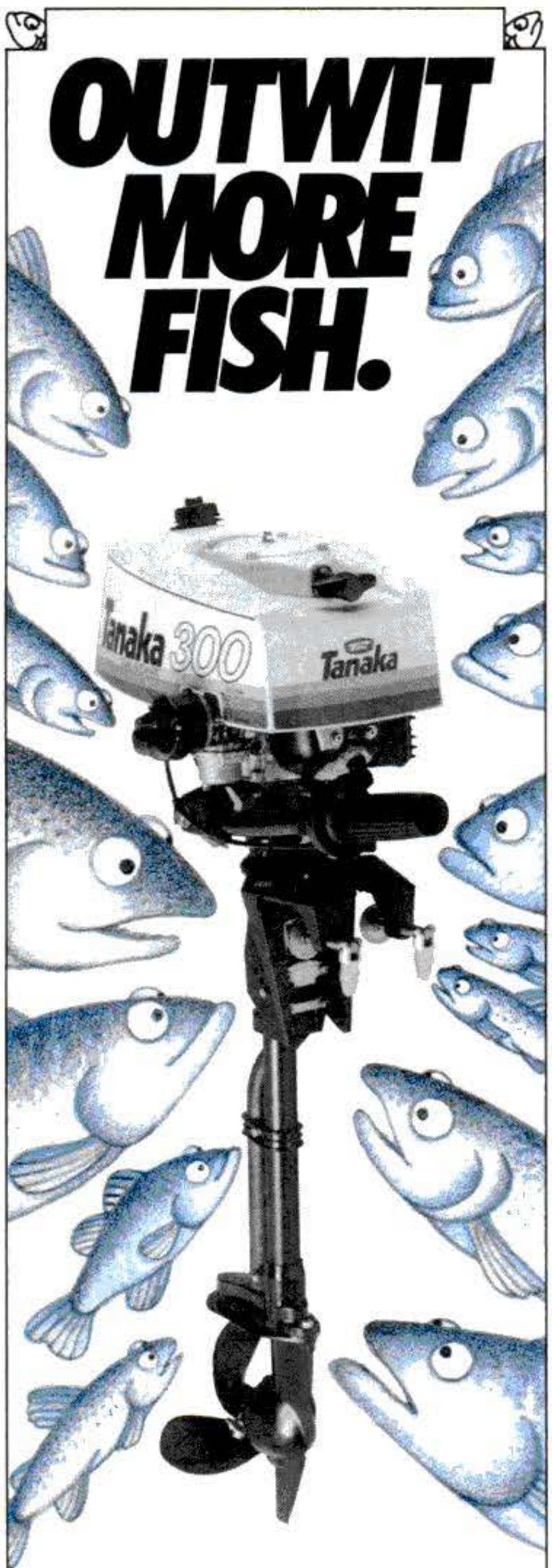

Do you dream about a lightweight gas outboard that can troll all day at a ¼ MPH, fine tune speed to current conditions, hold over a good spot, and maneuver in tight spots without spooking fish—all **without fouling or stalling?** Your dream just came true, and for about **half** the cost of most small outboards.

Tanaka's **Dual Automatic Drive** works much like an automatic transmission, so the engine doesn't have to "lug down" to maintain slow prop speeds. No other gas outboard runs cleaner or outwits more fish.

For a 1.2, 1.75, 3.0 or 5.5HP outboard and our dealer nearest you, call **TOLL FREE 1-800-426-7912.**

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To catch them, first find them

In case you haven't noticed, there's been a revolution in the way we fish. Sure, you can still take a cane pole and a can of worms and have a good time. But today's tackle is much more sophisticated, and smart fishermen use all of the latest equipment to help them catch more fish.

Nowhere is this more apparent than in fishing sonar. Today such units are universally accepted by anglers. But just 25 years ago they were the source of much controversy.

The Fish Lo-K-Tor, introduced by the Lowrance Company in 1957, found widespread acceptance among innovative fishermen. But it was also rejected by many anglers as well as fish and game departments. They felt it gave unfair advantage to fishermen, erroneously believing that it found fish. A number of states considered banning its use.

The fact is that fishing sonar is used to locate areas where fish are likely to be. Although a fish under you will show up as a signal, that is not the primary purpose. Instead, you look for fish holding structures. It's still up to you to catch the fish.

Today's sophisticated units give you a clear, concise picture of the water under your boat. Properly interpreted, you see what's beneath you and know exactly what the structure is like. If fish are hanging out in weeds, you look for weeds, skipping over mud flats and rocky bottoms. If the fish are relating to rocks, then you ignore the weed beds and look for rocky structure.

Learning to use sonar isn't easy. Although the manufacturer's instruction booklets include basic lessons in interpretation, you may need more instruction than that—especially if you've never used one before. A good source is Babe Winkelman's Comprehensive Guide to Fish Locators (Babe Winkelman Productions, P.O. Box 407, Brainerd, MN 56401). This combination booklet/audio tape program is the best learning tool we've seen on the subject, covering types of locators, how they work, and how to interpret the signals.

All depth finders, no matter the type, work the same way. A transmitter sends a pulse of sound energy down. It bounces off the bottom and returns to the boat. The unit measures the time between sending the pulse and hearing its echo. The elapsed time tells the unit how far it is to the bottom, or to some obstruction between the boat and the bottom. This is translated into feet, and displayed on a screen. Differences among units amount to the kind of display used.

Simplest is a digital readout, which merely displays the depth in numerals. Primarily used as a navigation device, these have little use for fishing, although they do find use among deep sea anglers and some Great Lakes salmon trollers who relate to water depth rather than structure.

Flasher units were, at one time, the most common. The original Fish Lo-K-Tor was of this type. A circular window, calibrated in depth, is used to show true bottom and any objects between boat and bottom. A neon bulb shows constant zero and another steadily records bottom depth. Objects between are shown as flashes of light at the correct depth.

Intensity of the flasher lights, the width of the signal, and how solid it is indicate type of bottom, size of fish, and kind of bottom growth.

Lowrance Electronics and Techsonic (Humminbird) are the best known names in flashers, but there are at least a dozen other companies making them, too.

Once serious fishermen learned the benefits of sonar, they began demanding something with a permanent record. Lowrance led the way again with graph recorders. Instead of a circular flashing window, these use styluses to burn a picture on a moving sheet of paper. They provide you with a detailed record you can analyze later. Want to know why that fish hit at a particular spot? Check the graph to see if there was some structural or environmental reason.

Graphs, thanks to microprocessor technology, are capable of many things. You can magnify a view, for example, so only the bottom and, maybe 10 feet of water show. Or focus on everything between 12 and 17 feet down. Many of them incorporate water

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temperature gauges, boat speed indicators, even a calendar. All of this information can be recorded on the graph paper for analysis.

To get the most use out of a graph recorder, leave it running at all times. Turning it on and off does not utilize it effectively.

Many fishermen, however, have moved away from using graphs, despite their advantages. Paper is expensive and is often a nuisance to change, especially out on the water. And most anglers don't keep the paper for later analysis. What these fishermen wanted was a unit that provided the detail of a graph recorder with the convenience of a flasher.

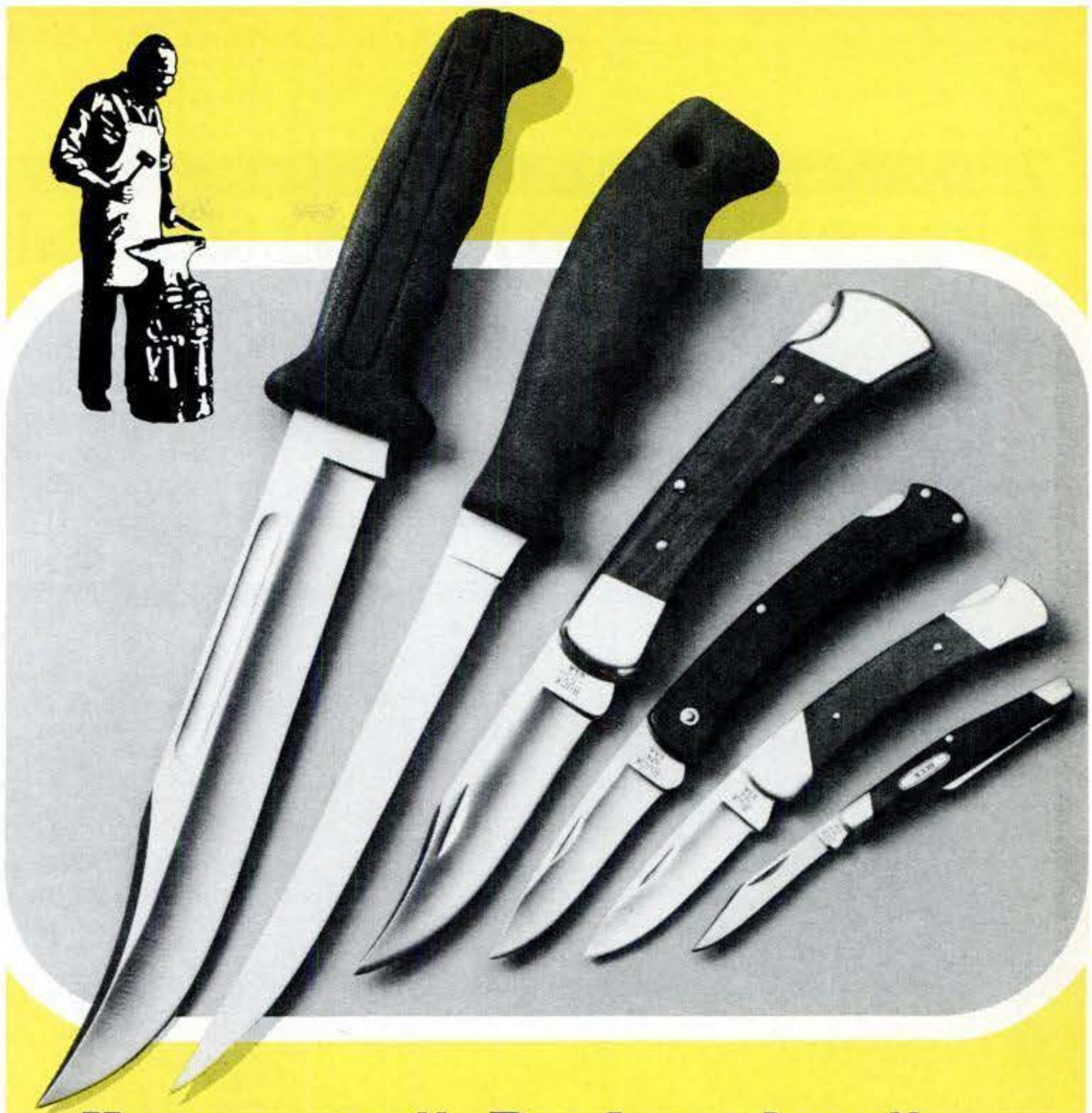
Such units are available. Called, variously, LCR (Liquid Crystal Recorder) or LCD (Liquid Crystal Display), they use microprocessors to produce an electronic picture on a liquid crystal screen. The picture is made up of tiny squares called pixels. Early units had too few pixels per square inch, thus giving a rather fuzzy image. But today's versions, like the Lowrance X-5 and Humminbird 8000 produce displays almost as detailed as graph records.

In fact, you have to look closely to realize that the picture is, indeed, made up of squares. The X-5, for instance, has about 2,400 pixels per square inch. If you're cramped for space (although none of the LCD units is really large), Furuno offers its LE4000, which is about the size of a paperback book.

Want to actually see what's happening under the boat? Then check out the VCR units, which work like your TV. The sonar translates its return signal into a set of lines that are flashed rapidly across a screen. They offer the clearest, highest resolution displays currently available. And they do it all in color. But you can spend up to $2,000 for one, putting it out of the reach of many sport fishermen.

Nevertheless, for those who want the latest in high-tech equipment, VCR is the answer. Furuno's FCV-66, for example, can show depths to 2,000 feet and displays on a six-inch screen in eight brilliant colors. The strongest echoes show in red, with weaker returns appearing in orange, yellow, etc. A special feature separates fish from bottom contours.

We've come a long way. But while all of the units I've mentioned will help you *locate* fish—it's still up to you to catch them. ■



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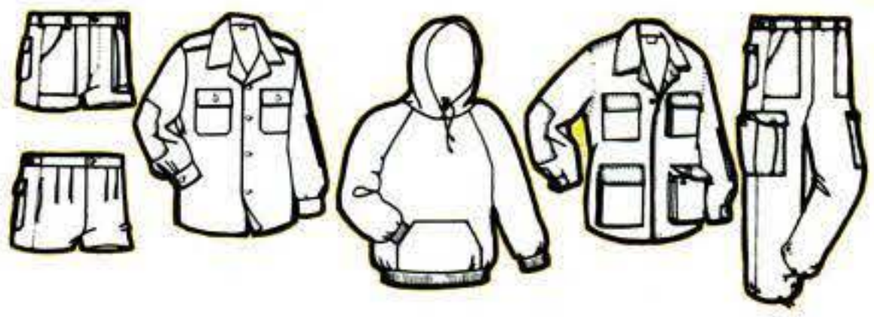

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Icing your catch—keeping fish fresh

You've all seen those jealousy-inspiring photos of successful anglers holding aloft stringers of fish. Very dramatic pictures—they make good art.

They also make for poor fish on the table! Towing fish around on a stringer is the second worst way to treat them. The first, of course, is to toss them onto the bottom of a boat to lie in the hot sun.

Fish are delicate creatures with a very high metabolic rate. Most fishermen have had the experience of catching a fish that had a baitfish partially swallowed. The tail end was still sticking out of the game fish's mouth, but the head of the baitfish had already been dissolved in the big one's stomach.

That sort of digestion rate spells trouble, because it leads to very rapid spoilage. Although the fish may be dead, no one told its digestive system, and its stomach fluids continue working. That's why uncared for fish smell, and taste fishy.

What's wrong with using a stringer? Nothing if it could insure both that the fish would stay alive on it, and that the stringer remained in cool water. Usually, neither of these conditions prevail.

More typically, fish are snapped onto a stringer that is attached to a convenient spot on the boat, like an oarlock or seat bracket. Often the stringer barely makes it into the water. When you finish fishing a particular spot, the stringer is hauled into the boat, you move to another spot, and the stringer is thrown back overboard. Sometimes, in the rush to continue fishing, you forget to put it back.

This is rough enough treatment using a snap-type stringer, where the fish has at least some chance of staying alive for a while. With a straight cord stringer, the kind that passes through the fish's gills, it is impossible for it to live more than a few minutes.

The fish are dragged around this way until they die, then spend the rest of the day in that warm surface water. Three strikes against them!

Three? That's right. The third worst thing you can do to a dead fish is to put it in water. There are two reasons: (1) The mucus coating that makes the fish slippery stays that way only as long as the fish is alive. Once it's dead, that coating, when wet, turns to slime. This is true for cleaned fish as well as uncleaned ones. In fact, the entire controversy surrounding the question of whether or not cleaned fish should be washed probably stems from this. There is nothing wrong with giving fillets a quick rinse. Whole fish, however, should not be allowed near the water. (2) Soaking a fish promotes softness of flesh and loss of texture and flavor. Bacterial growth is promoted, thus hastening spoilage.

What's the solution? Obviously, if

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your boat is equipped with a live well, use it. If not, or if you're shore fishing, icing the catch is the answer. Fish destined for the table should be cleaned immediately (either filleted or gutted and gilled), and put on ice. It doesn't take long to do, and it's the only guaranteed way to be sure of fresh-tasting, wholesome fish dinners.

Fishermen who keep a bag of ice in the cooler, and toss the whole fish into it until day's end, are a step ahead of the "put 'em on a stringer" boys. But, they should go that extra step and clean the fish before putting it on ice.

Be certain to observe all regulations concerning cleaning of fish. Virtually every state has laws against dumping entrails or other unused parts of cleaned fish into the water; carry a trash bag for waste. Some states also require that skin be left on fillets while transporting them. Always check local regulations.

Put a layer of ice in your cooler, then lay the fish right on it. Be sure to drain the water as it melts, though, to keep the fish from lying in it. If that's difficult, put the cleaned fish in plastic bags, then bury them in the ice.

Choosing a cooler

Whether you're a bank fisherman, work out of a small John boat, or troll in a 30-foot salmon boat, there's a cooler available to fit your needs: from Coleman's four-gallon Poly-Lite all the way up to Gott's 172-quart Marine Chest with its optional built-in seat cushion. Even the small soft drink-sized coolers, such as Coleman's Lil' Oscar and Lunch Pak can be used, especially if you have a load of panfish fillets.

If you're near your car, or if your boat has a cigarette lighter, you can use one of the portable electric coolers. These require 12 volt service, or can use house current with a converter. Both Norcold and Koolatron make portable models. Norcold's, because it uses a compressor, can be converted to a freezer as well. Koolatron uses a bi-metal system, which only lets you cool the contents 50 degrees below ambient temperature. It also has a heating cycle, in case you want to keep your coffee and chili hot during those cold weather fishing trips.

According to Koolatron's Gary Clark, you could run a medium sized (48-quart) cooler off your car battery for eight hours before the battery would need recharging.

Among the non-electrics, there are many cooler choices, both of materials and styles.

- *Polystyrene foam*. Usually referred to by the registered Styrofoam brand name, these are the lightweight, white foam coolers and buckets found in most bait and tackle shops. Generally, they're not airtight and are easily damaged. On the plus side, they're inexpensive enough to be especially appealing for those once-a-year trips.

You can buy the size you need on the scene, then use it for something else when you get home. On the minus side, their cost makes them so disposable that people often leave them behind. Thus you may see them all over the shoreline and

Continued

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"Fish destined for the table should be cleaned immediately (either filleted or gutted and gilled) and put on ice."

floating in the water. Don't be guilty of that!

- *Polyethylene*. Polyethylene coolers, the most common kind around today, are virtually indestructible in normal use. Usually they have foam insulation and a plastic liner. According to Coleman, the most popular size is 12 gallons. The carrying handle is a good indication of a cooler's durability. Coolers with flimsy handles usually have shoddy construction overall.
- *Metal-clad*. Once fairly common, these have been generally displaced by polyethylene because of weight. Metal-clad coolers have foam insulation and plastic liners. The better ones also have tough plastic bases to overcome the big problem with metal coolers: rust. The bottom, for obvious reasons, is the area most susceptible.

Within reason, pick the size of your cooler based on the size and number of fish you expect to put in it. But, as the folks at Coleman point out, if it takes two men and a grown boy to carry a cooler, it's too large. In most cases, two smaller coolers will be a better investment than one large one.

Cooler care is simple. Just hosing it out at the end of the day should suffice. Occasionally, you have to wash it with hot water and a mild detergent. Never use harsh scouring powders. For particularly stubborn stains or odors, scrub with a sponge dipped in baking soda.

Mating your catch to your cooler consists of more than just tossing in some ice. You want to maximize the effects of the ice as much as possible.

As a rule, block ice lasts longer and cools better than chipped ice or cubes. But at the same time, you want to partially bury fresh fish in the ice.

The solution is to line the bottom of the cooler with block ice, then add a layer of shaved ice an inch or two thick. Clean your fish and push them down into the shaved ice. If possible, it's a good idea to put the fish in plastic bags to keep melted ice water off them. Squeeze as much air out of the bags as you can before sealing.

Instead of buying block ice, you can fill empty milk containers with water and freeze them. An even better bet is to fill the containers with juice. Then, as the juice melts, you drink it.

A good trick, if you have access to a freezer large enough to hold your cooler, is to fill it with a couple of inches of water and freeze the whole thing. I like to go five or six inches when I do this in a smaller cooler, and as much as ten inches in a large one.

This approach does two things: first, it prechills the cooler, always a good idea. And second, it creates the kind of block ice you want as a base, with no air pockets.

Incidentally, none of these cooling techniques should be used with frozen fish. Putting them on ice will defrost them, because the ice, at 32 degrees, is warmer than the frozen fish. Use dry ice, rather than water ice, for frozen fish. ■

Millions of acres in public lands

Despite cries about shrinking recreational lands, there are actually millions of acres of land and water owned by all of us. Federal and state lands are found in every state—from small pocket parks to the giant National Parks and Forests.

Less known are the public lands managed by other Federal agencies. For example, the Army Corps of Engineers maintains a public easement along the entire length of the Missouri River.

Of course, the pressures to create more recreational areas across the nation are, to some extent, justified. Our National and State parks are flooded with visitors, and the values that attract so many people to the parks—open space, greenery, clean air, established campsites—are threatened by the crowds they draw.

The trick, then, is to seek out less crowded alternatives, such as the more than 272 million acres managed by the Bureau of Land Management (BLM).

The BLM is hardly known in the east. But it is an important agency in the western states and Alaska, charged with various land and water-management duties. These lands offer

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numerous opportunities for camping and boating near natural, scenic, and historical resources.

There's a misconception that BLM lands are only open to those who prefer roughing it in primitive camping areas. Those, the myth goes, who look for developed campsites with amenities are out of luck. Not so! The public lands have a wide variety of both types of camping, and the areas surrounding these campgrounds offer opportunities for other recreational activities like picnicking, hiking, fishing, hunting, floatboating, rock collecting, canoeing, rafting, cave exploring, snowmobiling, and off-road vehicle use.

BLM also administers numerous river segments where visitors can enjoy motorized or non-motorized boating activities. Some of these rivers are included in the National Wild and Scenic Rivers System.

Off-road travelers, especially, should check out BLM facilities. Perhaps more than any other recreational land users, off-roaders find themselves out in the cold when it comes to using their vehicles. BLM lands are generally open to this use, especially in the deserts of California, Nevada, Arizona, and Utah.

These public lands are rich in historical and archaeological sites and artifacts. Tim Locke of the BLM's public affairs division cautions that these fragile resources are protected by Federal law, and the penalties for unauthorized collection include stiff fines and imprisonment. "Unfortunately, many of these irreplaceable links with the past are destroyed, either intentionally by vandals, or unintentionally by casual collectors. Visitors should enjoy, but not remove or disturb these remnants of early American cultures."

Always check with the nearest BLM office for information on the areas you plan to visit. Detailed maps and current info about conditions can be obtained from the field offices.

State offices are located in Anchorage, Alaska; Phoenix, Arizona; Sacramento, California; Lakewood, Colorado; Boise, Idaho; Billings, Montana; Reno, Nevada; Santa Fe, New Mexico; Portland, Oregon; Salt Lake City, Utah; and Cheyenne, Wyoming. Information about BLM lands in the eastern states is available from the office in Alexandria, Virginia. ■

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Outdoor edges—knives, axes, and saws

Since the beginning of time, mankind has been fascinated with edged tools. Indeed, it's easy to make a strong case for the concept of civilization being a result of the knife.

Whether or not man got where he is because he had a knife is a moot point. Unarguable, though, is the fact that today's outdoor man—and woman—and child—has a love affair with edges.

A recent study indicates that the average outdoor enthusiast owns from nine to thirteen knives. Toss in the other edges deemed necessary to the outdoorsman—saws, axes, camp tools, and such—and you have a staggering array of cutlery.

Is it all necessary? Not at all. But, it's great to have the exact edge needed for a particular job. Even greater is to have a knife you can brag about, one to show off to the boys at the corner store, or your next fishing club meeting.

As working tools, though, there are only a few cutlery pieces you need, depending on your outdoor pursuit, the specifics of the job, and how much you're willing to carry.

I never leave for an outdoor trip without at least two knives; often, I carry three or four.

Which knife style and blade shape is the right one? Since a man's knife is a very personal thing, the best I can do is discuss some of my choices.

First and foremost is a single-blade folding lockback knife, such as the Buck Folding Hunter. That's my basic utility knife. In a pinch I feel I could survive anywhere armed with such a blade. Knives like these are, in fact, the mainstay of the knife business.

The second knife is determined by conditions. If I'm going hunting, for instance, I'll want a skinning knife, preferably one that folds. And usually I carry one with a gut hook. Knives with interchangeable blades, such as the Gerber Bolt-Action Exchange Blade provide blade choices without adding too much bulk on your belt.

For fishing, I like a utility knife for the tackle box, and a good fillet knife for cleaning fish. For the tackle box, a single, double, or even triple bladed knife fits the bill. Virtually all knife makers offer "pocket" knives that work just fine. Or, one of the folding fillet knives makes a good general purpose tackle box knife.

The folders are not the best choice as fillet knives, however, because they are difficult to keep clean, and many of them do not feature locking blades. For cutting bait and fishing lines they're great. But go to a fixed blade fillet knife

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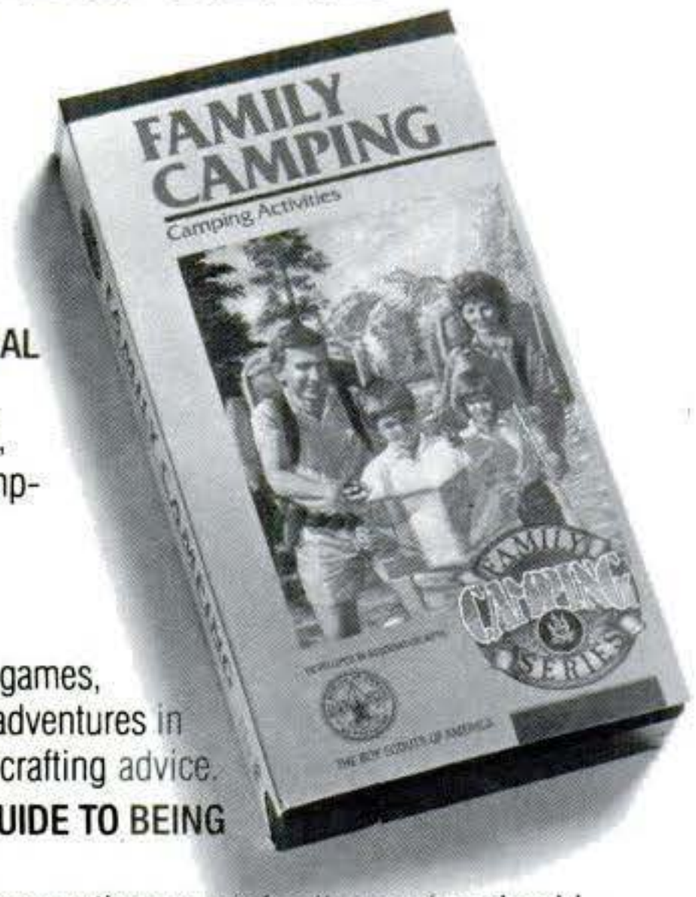

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for cleaning fish.

Years ago, most fishermen gutted and gilled their catch, so fillet knives were rare. Today filleting is almost universal, so all manufacturers offer fillet knives.

They come in many sizes and shapes. When choosing one, get the largest possible. A 10-inch knife can be used to clean a bluegill. But you wouldn't want to try filleting a salmon with a 4-inch blade.

I've got a drawer full of fillet knives, in all sizes and shapes. Of them all, I prefer the Condor from Hoffman Designs. Although at first I was put off by its up-curving design, I now prefer it. And the combination flexibility of the 9-inch blade must be tried to be appreciated. The front of the blade is thin and limber, as a fillet knife should be. The rear few inches, however, is stiff for added strength when cutting bone.

There are other edges sportsmen should consider when going afield. Chief among them is a belt ax. Here we face a compromise between weight and bulk on one hand, and utility on the other.

For my money, the Buck belt ax can't be beat. It should not, however, be used to chop firewood. That job is reserved for a full ax. But for cutting kindling, and as an aid to field dressing large game animals, it is a real winner.

Even better than a full ax is a camp saw. About a half dozen companies make a similar model: essentially a triangular shaped saw blade with an adjustable handle, carried in its own belt sheath. I can recommend the Uncle Mike's version because I've used it. However, there's no reason to believe that similar designs from Buck, Coghlan's, and others would be any less effective.

Edge care is a story by itself. Most knife owners have trouble maintaining the proper blade angle with a traditional oilstone. However, store shelves are filled with sharpening aids, ranging from clamp-on jigs that maintain the right sharpening angle to ceramic rods, preset at the right level.

Lansky has a broad line of such sharpening aids. For the general outdoor enthusiast, that company's new Fold-A-Vee sharpener is the answer. It has ceramic sticks imbedded in a folding plastic frame that quickly sets up for use. The whole rig is lightweight, compact, and effective.

Armed with a Fold-A-Vee, or other modern sharpening aid, today's sportsman should have no trouble keeping his blades sharp at home or in the field. ■

A Final Word From the Publisher

I sincerely hope you found this special section to be both informative and entertaining.

As you probably know if you are a regular reader, *Popular Science* covers outdoor recreation subjects on a continuing basis, both in feature articles, and in "What's New in Recreation."

Fifteen years ago, in the magazine's 100th Anniversary issue (May '72), the editors identified preservation of our recreational resources as one of the major technological challenges of the future.

Coincidentally, that year also marked the Centennial of the National Park System. Our first National Park, Yellowstone, was established just two months before the founding of *Popular Science* in 1872.

The director of the National Park Service in 1972, George B. Hartzog, Jr., contributed an article to PS's Centennial issue: "Can the National Parks meet your changing needs? As our National Park System enters its second century, it faces challenges its founders never dreamed of..."

While government continues to tackle this challenge today, all of us can help to preserve not only our National Parks, but all of our priceless recreational resources so that they may be enjoyed by our children, and their children as well.

Grant A. Burnett
Publisher

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The Great 1987 Outdoors Product Information

Booklets, catalogs, and folders listed below provide reliable information, illustrations, and specifications to help you in planning the purchase of a variety of products or services offered by these dependable companies. The convenient order form will save you time and postage. **Orders will not be processed unless accompanied by the $1 handling fee. For your safety, please do not send cash.**

501 Knife How-To Buck Knives' updated information kit contains tips on knife use and care, including general dos and don'ts. It offers specific facts about knives so that you can select the best one for your needs. The kit also tells you how to sharpen your knife, field-dress deer, and fillet fish. Free

502 Outboard-Motor Guide The "Handy Guide for Small Outboard Selection" helps you answer the question, How much horsepower do you really need? It's available from Cruise 'n Carry. Free

503 Power Cutters A 22-page four-color brochure from Husqvarna lists its complete line of chain saws, clearing saws, grass trimmers, hedge trimmers, and protective apparel. 25¢

504 Camper's Guide A 124-page directory from Kampgrounds of America lists KOA North American campgrounds. The guide includes full-page full-color travel maps. $2

505 Outboards Suzuki's two full-color catalogs describe its 1987 outboards, from the 2-hp model to the 200-hp V6, with True Oil Injection and Power Trim standard on many models. The Suzuki 150 Super Six is the only V6 with production dual plug heads and comes with hood louvers to get more air in for higher performance. Free

506 Hauling Guide The 15-page "Custom Hitch Guide" from U-Haul includes information on choosing the right hitch for your car. Safety tips and complete trailer-towing accessories—from hitch balls to mirrors—are also featured in the guide. Free

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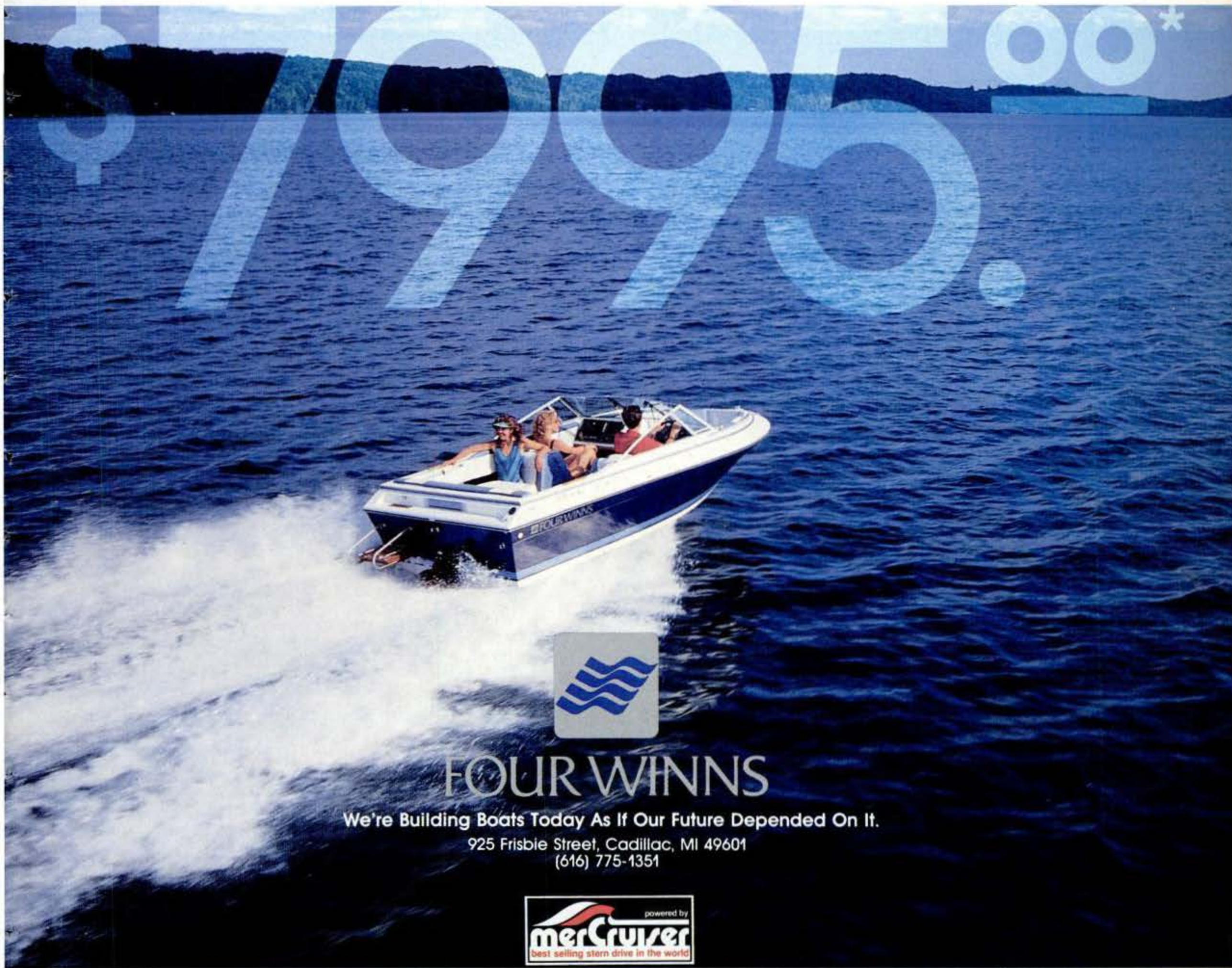
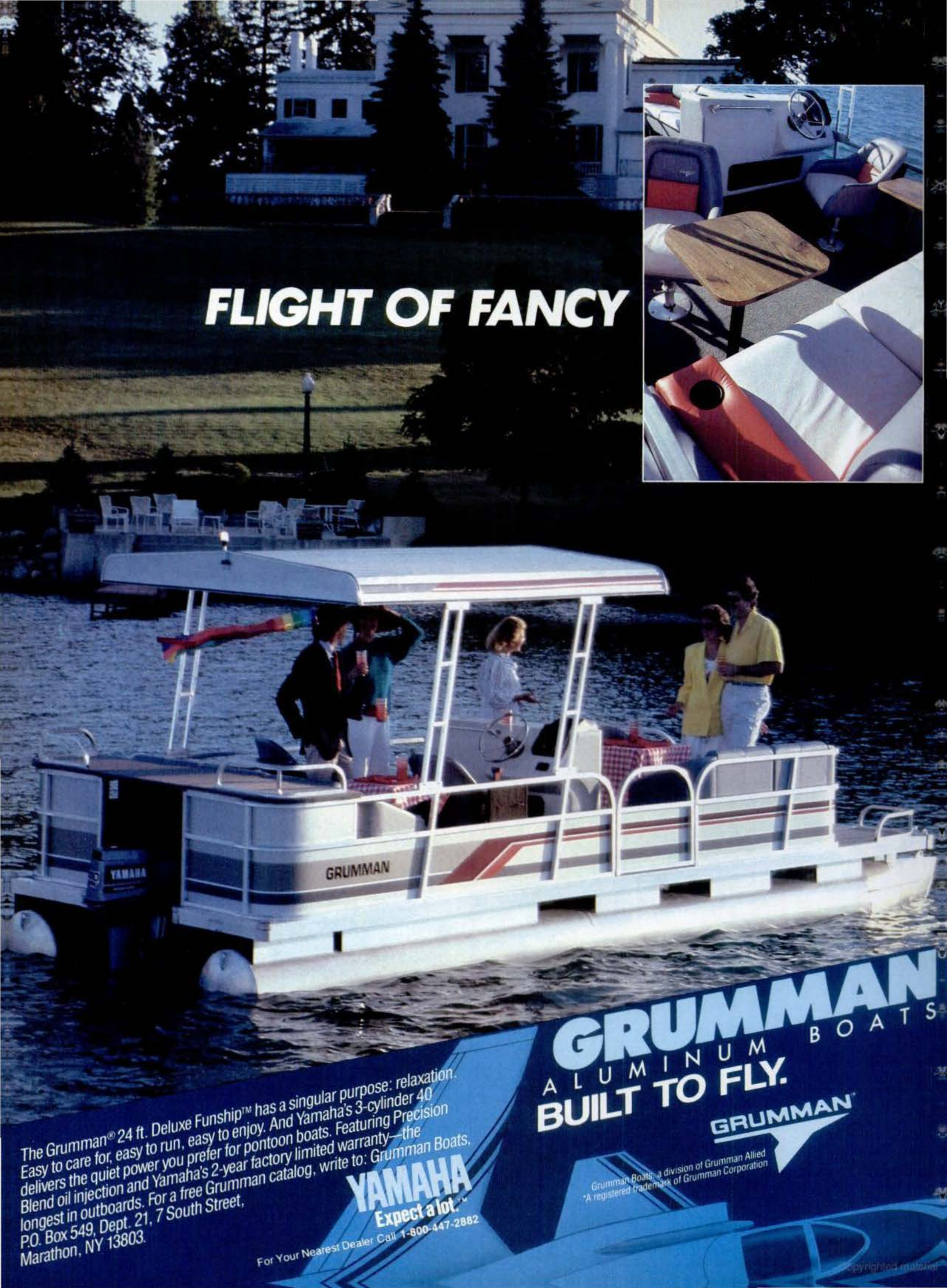
**Full warranty details are available at all Four Winns Dealerships.

A group picture of the Four Winns Freedom and all the other Boats in its class.

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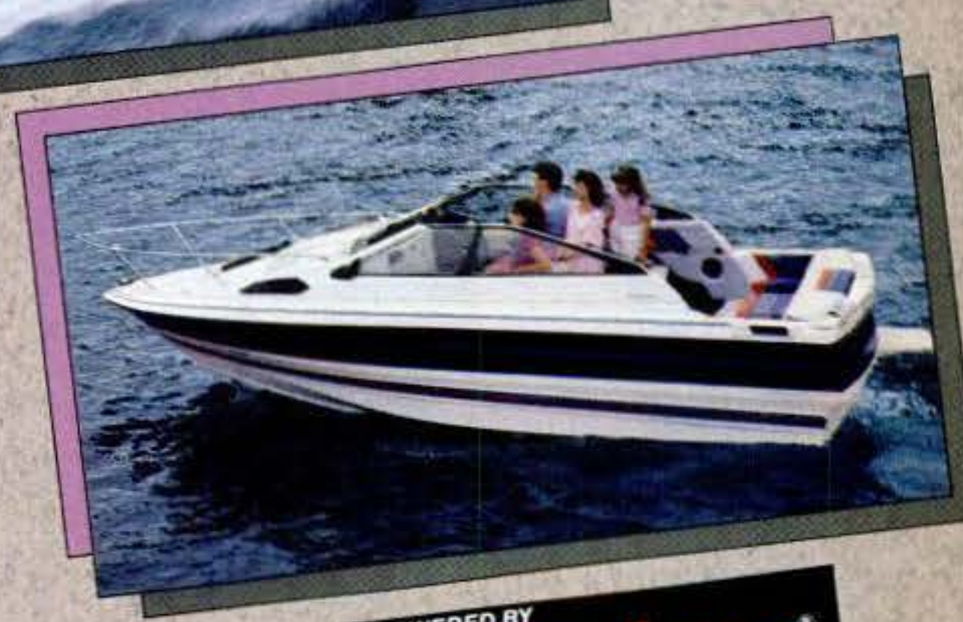

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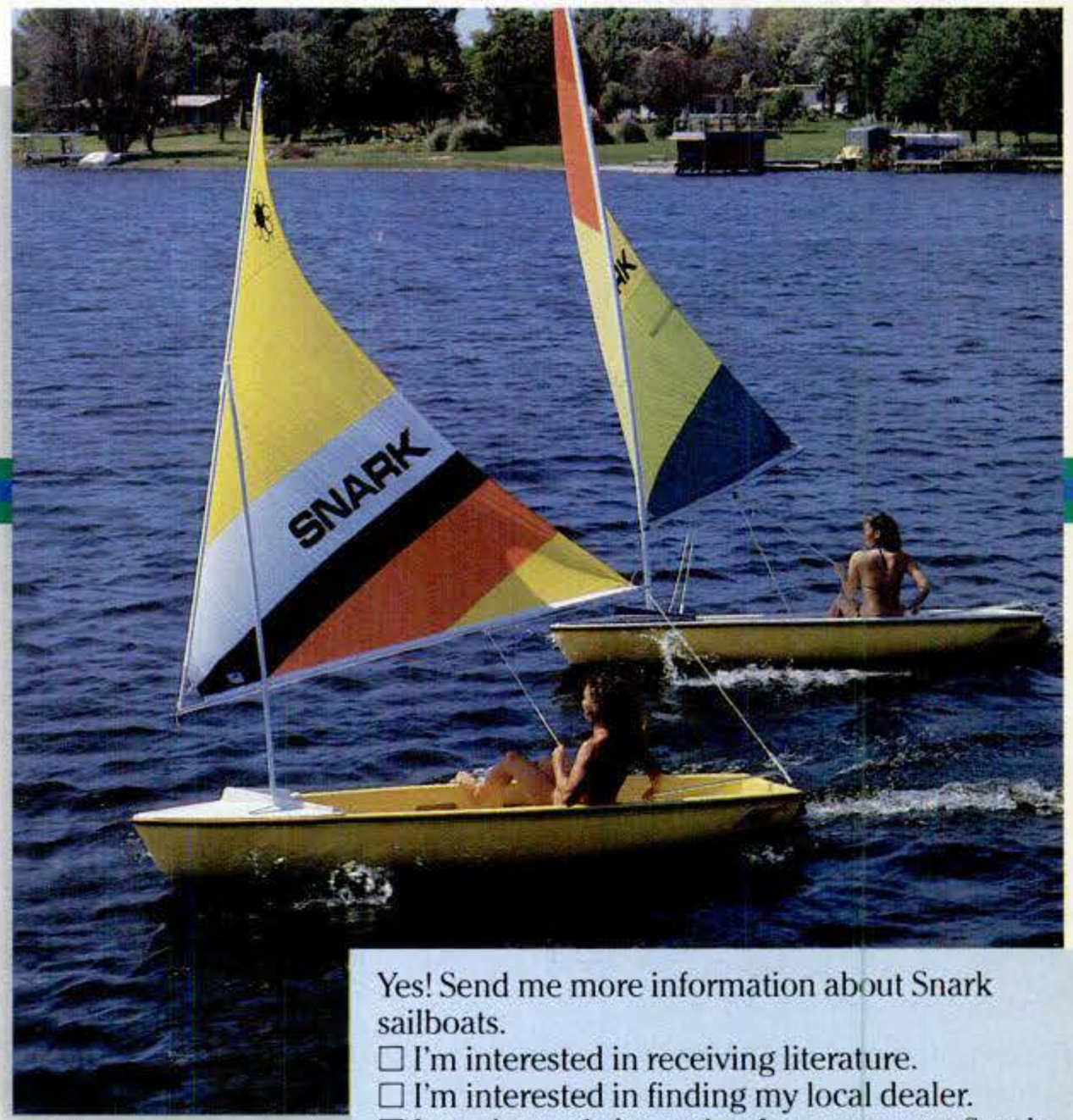

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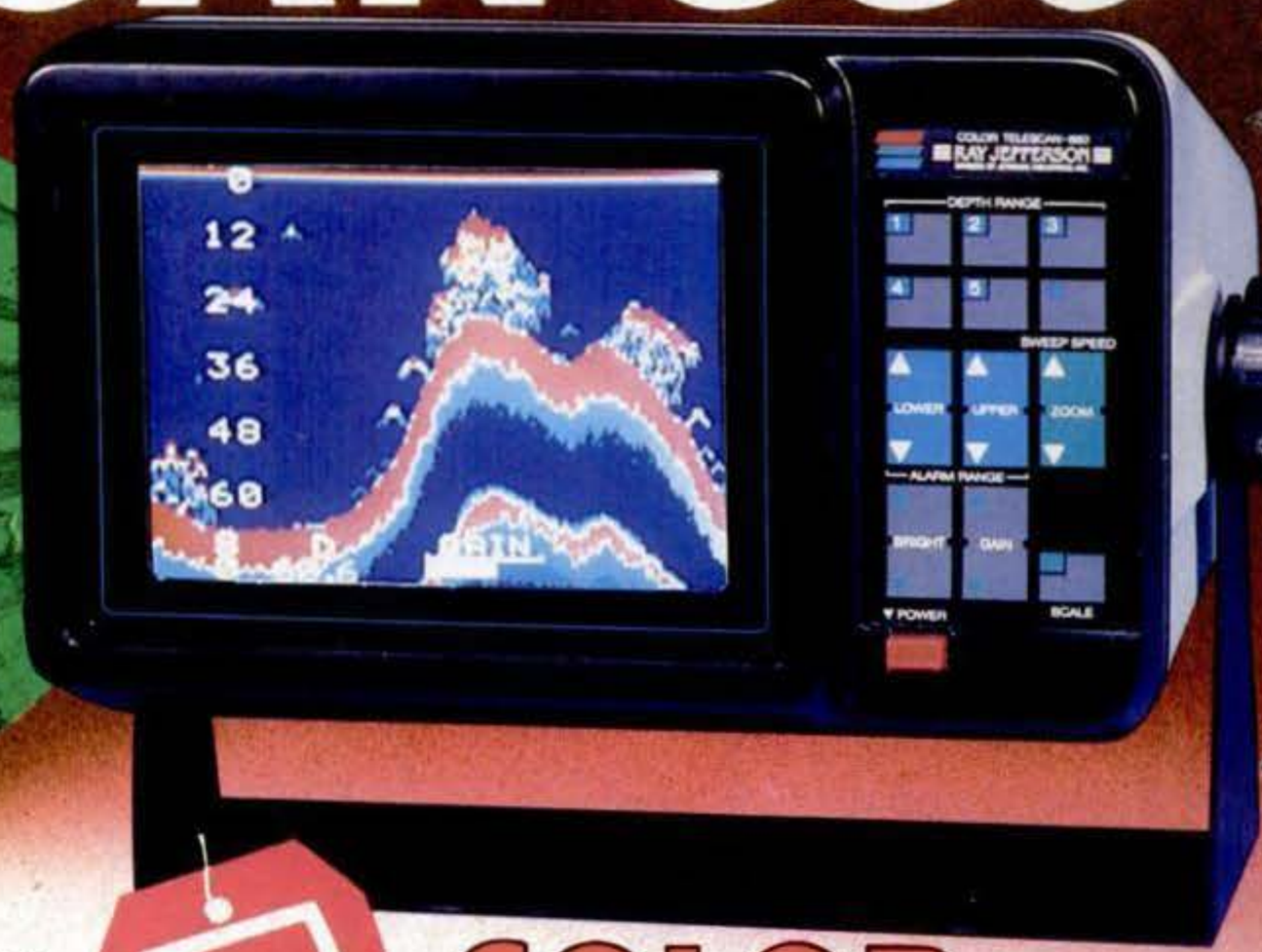

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Performance sentinels

Oxygen sensors fine-tune the air-fuel mixture to keep an engine running most efficiently. Here's how these amazing sensors work, and how to keep yours doing its job properly.

By KENNETH ZINO
Drawings by Russell von Sauers

Bud Robinson put his hand loosely over the carburetor of the idling engine. As the engine began to shake a bit more than previously, the digital voltmeter in Robinson's other hand read 0.8 volt. When he took his hand off the carburetor, the idle smoothed and the voltage reading dropped to 0.3 volt.

"See, when I make the gasoline mixture richer by restricting the air intake with my hand, almost one volt is produced," Robinson said. He did it again for effect—0.8 volt with his hand on the carb, 0.3 with it off. The veteran mechanic was demonstrating an oxygen sensor at work.

Oxygen sensors, a recent addition to automotive technology, have made a previously complicated task easier. Engineers can now design an engine that performs well without producing illegal amounts of harmful pollutants. Better yet, it will stay in tune for 50,000 miles or more with only minor maintenance. This is quite a change from the early 1970s, when primitive emissions controls resulted in engines that ran roughly no matter how carefully they were tuned.

Although an oxygen sensor looks like a spark plug, its function is entirely different. And unlike a spark plug, which is practically indestructible, oxygen sensors can be easily damaged by the wrong fuel or improper repairs. The result can be an engine that idles roughly, lacks power, pollutes the air, and uses too much fuel.

An oxygen sensor is also far more expensive than a spark plug—some cost up to $100—so it's not something to routinely replace as part of a tune-up. Yet the truth is that a lot of units are replaced unnecessarily. An understanding of how these sensors work and how you can keep them working properly—and how to tell if they are—will not only help keep the air we breathe clean, it will save you money.

Clean air and the O_2 sensor

Prior to the passage of clean-air laws during the 1960s and 1970s, automobile engines were designed with little regard for the pollution they caused. Today, however, the amount of byproducts produced—specifically carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NO_x)—is limited by law. Engineers, after trying out various ways to limit emissions, have settled on a strategy that first lowers the production of harmful gases, then converts the rest into less noxious compounds like water vapor and carbon dioxide.

The key was the catalytic converter, a muffler-shaped device that uses platinum, palladium, and other catalysts to oxidize and reduce harmful gases.

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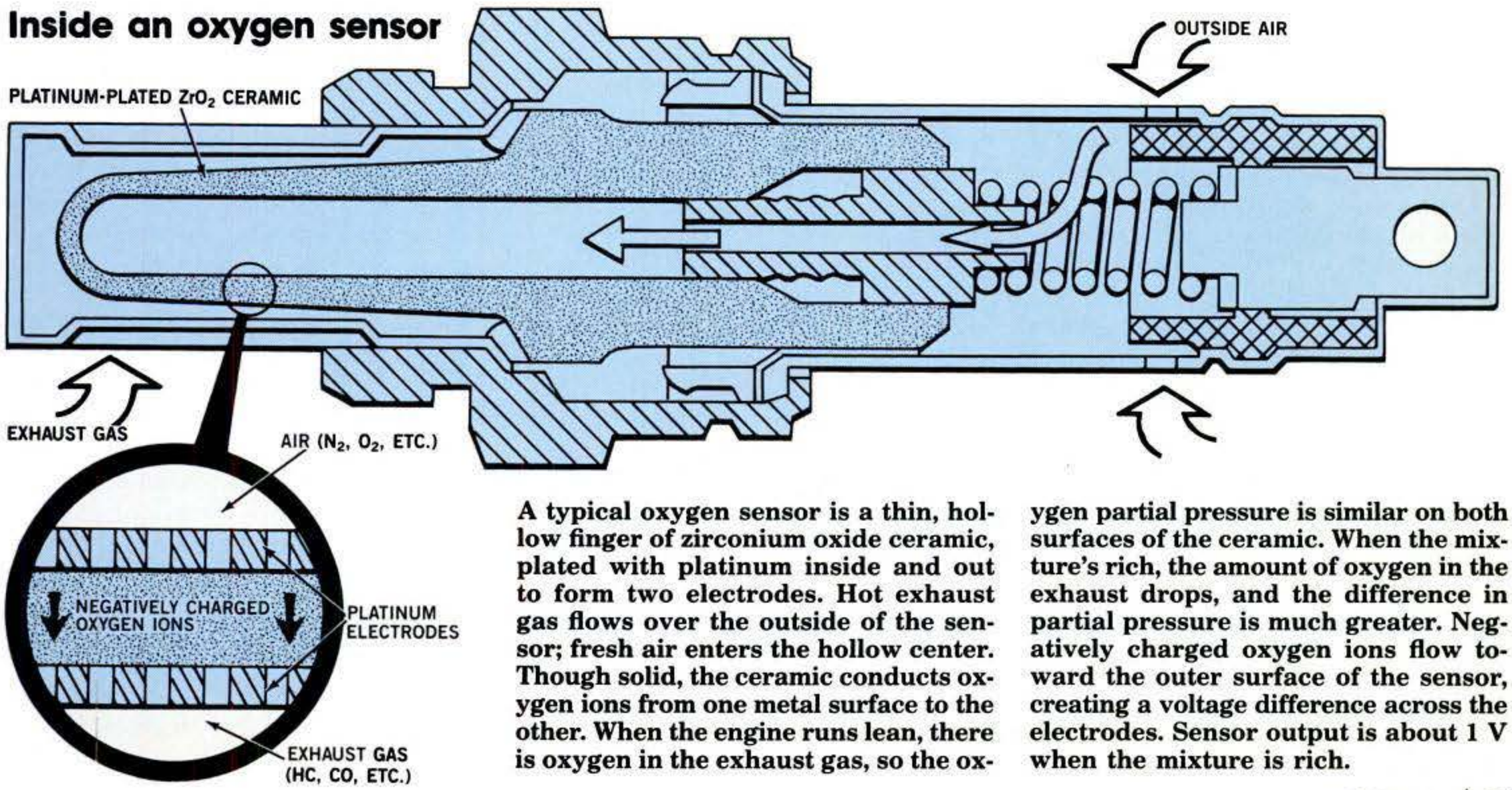
Inside an oxygen sensor



A typical oxygen sensor is a thin, hollow finger of zirconium oxide ceramic, plated with platinum inside and out to form two electrodes. Hot exhaust gas flows over the outside of the sensor; fresh air enters the hollow center. Though solid, the ceramic conducts oxygen ions from one metal surface to the other. When the engine runs lean, there is oxygen in the exhaust gas, so the oxygen partial pressure is similar on both surfaces of the ceramic. When the mixture's rich, the amount of oxygen in the exhaust drops, and the difference in partial pressure is much greater. Negatively charged oxygen ions flow toward the outer surface of the sensor, creating a voltage difference across the electrodes. Sensor output is about 1 V when the mixture is rich.

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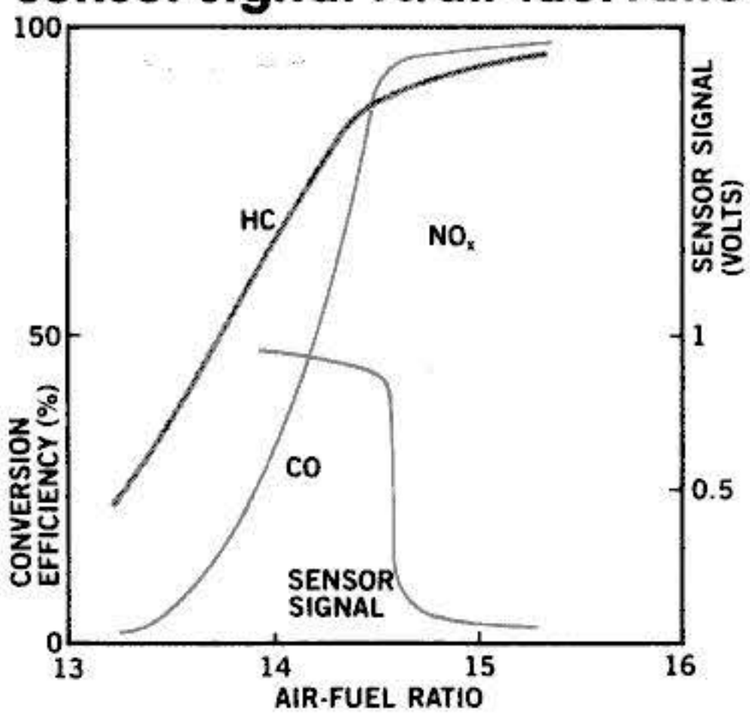
Catalyst efficiency and sensor signal vs. air-fuel ratio



The switching point for an oxygen sensor is when the air-fuel ratio is optimal —which is also where the three-way catalyst is most efficient.

Beginning in the mid-1970s, an oxidation catalyst was installed on some cars to oxidize hydrocarbons and CO into CO_2 and water vapor.

These catalysts did nothing to control NO_x emissions, however, so most cars produced since the 1981 model year have a more sophisticated three-way catalytic converter that can reduce oxides of nitrogen as well as oxidize HC and CO. One serious problem exists with a three-way converter, though. It cleans all three pollutants efficiently only when the air-and-fuel mixture being burned by the engine is at a specific ratio. This point occurs when there is just enough oxygen present to allow for the complete combustion of gasoline—when 14.6 parts of air are supplied to one part gasoline.

An engine can run smoothly over a range of air-fuel mixtures, explained Carlos Barrera, an engineer who designs oxygen sensors at Ford. "The reason for operating at 14.6:1 is not because engine designers like that point. Rather, the catalyst itself is most efficient there."

Because the engine must always operate at the optimal air-fuel ratio, some method is needed for fine-tuning the mixture to compensate for changes in speed, load, fuel quality, and such. "It so happens that an oxygen sensor operates at this optimal ratio, too, so it's a perfect mate for the catalytic converter," Barrera said.

How oxygen sensors work

Barrera explained that an oxygen sensor generates about one volt across its electrodes when the mixture is too rich and there is insufficient oxygen for complete combustion. If the engine is running lean, voltage output drops to nearly zero (see cutaway and caption). This switching point occurs at the optimal air-fuel ratio, and it occurs very abruptly. The on-off signal created as the mixture crosses from rich to lean is a language understood perfectly by computers: The oxygen sensor generates a digital signal.

Ford and other car makers use an oxygen sensor to tell the engine control computer when the mixture is too rich or lean for maximum catalytic-converter efficiency. The mixture is then adjusted by changing the amount of fuel delivered by the carburetor or fuel injectors. If the mixture is too rich, it's made slightly leaner; too lean, and it's adjusted back the other way. This constant fine-tuning keeps the mixture close to the sensor's switching point, which keeps it close to the best air-fuel ratio.

The oxygen sensor, the key component in this feedback loop, is easily spotted in the engine compartment of your car. It's mounted in the exhaust manifold, usually as close as possible to the engine. As previously noted, it resembles a spark plug. Unlike a spark plug, it can have one, two, or three wires attached to it, depending on its design.

A typical sensor used by Chrysler, Ford, General Motors, and European and Japanese imports has only one wire attached. This is its link to the computer. Like most electrical components, the sensor is grounded through the metal manifold and engine block, although some GM sensors have a separate ground wire. A few have three wires, two of which are for a small electric heater.

Like some people, an oxygen sensor doesn't function well when it's cold. Exhaust gas needs to heat it to about 350 degrees C before it produces a reliable signal. That's why an oxygen sensor is mounted close to the engine, where gases are hottest. That's also why the sensor may have a built-in heater to keep it at the ideal operating temperature of about 700 degrees C.

What can go wrong?

An oxygen sensor usually doesn't require routine maintenance. And because it's an emissions-control component, a sensor is guaranteed for five years or 50,000 miles by the manufacturer, provided you service the car according to the maker's recommendations. (Some cars, mostly European, do require a sensor change before 50,000 miles. Check your owner's manual.)

"If you treat a sensor with a little care, it will work fine," said Mark McMackin, product engineer for oxygen sensors at Chrysler. A sensor of recent design should last the life of a moderately driven car, added McMackin. Still, physical abuse, neglect of other engine components, using the wrong fuel or lubricant, or just plain bad luck can relegate a sensor to the trash.

Physical abuse is easy to prevent. When working under the hood, be careful not to hit the sensor with a wrench or pry bar. Although ceramic is extremely hard, it's also brittle —and a sharp blow will crack it. Also, don't spray the sensor with undercoating, rustproofing, or solvent, which can block the flow of outside air to the inside of the sensor. This can change the calibration because the reference air is blocked or can cause the sensor to fail entirely. Leaking engine oil, brake fluid, or power-steering oil can have the same effect.

Sensor poisoning by lead or silicon is much harder to guard against. It's invisible, and can result from the inadvertent use of the wrong fuel or other chemicals.

"Be careful that you buy gasoline from a reputable retailer," warned Bruce Holleboom, a development engineer for the AC Spark Plug Division of GM. "It's more likely that you will have a problem with an oxygen sensor due to poisoning by bad gasoline than for any other reason."

Lead and silicon are the contaminants in gasoline that cause the most problems. The effects of poisoning vary from slight shifts in the engine's air-fuel ratio to complete failure of the sensor. Slight poisoning may go unnoticed by a car owner. It's only in extreme cases—when the sensor is severely poisoned or fails entirely, for example—that fuel economy or drivability deteriorates to the point where it's noticed by the driver or the "check engine" light flashes on.

Aside from deliberate misfueling by the owner, lead can end up in a car because the gas station is pumping leaded fuel in place of more expensive unleaded. Such practices are illegal but may be difficult for a driver to detect. Sometimes independent operators are innocent: They buy fuel from wholesalers and are unaware of its chemical composition. And, occasionally, fuel is accidentally mislabeled or contaminated during handling.

Whatever the reason for misfueling, the results are the same. Lead deposits coat the oxygen sensor, eventually causing it to fail. How long it takes for performance to be adversely affected depends on the specific engine and its operating conditions.

The harder the engine has to work, the higher the engine exhaust temperature. If leaded fuel is added at temperatures above 900 degrees C, "it's

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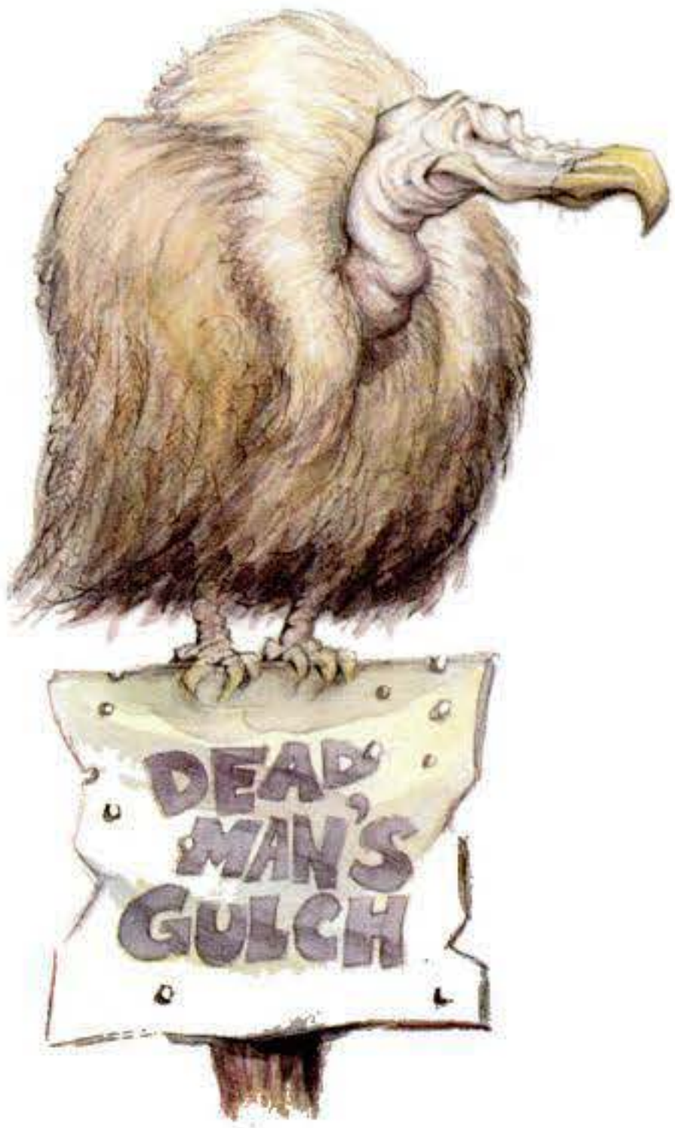

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like coating the sensor with a high-temperature varnish," said Holleboom. This permanently blocks the flow of ions between the two surfaces of the sensor; replacement of the sensor is the only cure. Worse, if the car still has leaded gas in the tank, it's possible that the new sensor will also be poisoned.

Oxygen sensors exposed to less hellish conditions can survive several thousand miles of lead contamination. A sensor that hasn't failed can return to normal operation after just one tank of genuine unleaded fuel is used, because the deposits will burn off the exhaust side of the sensor. "A Detroit-area police department provided a classic example," Holleboom said. "Suddenly, patrol cars couldn't go fast enough to catch speeders. But by the time trouble-shooters arrived, tickets were again being issued. I think that a new batch of unleaded fuel delivered to the fleet garage had helped restore law and order."

Similar poisoning is caused by silica, the combustion byproduct of silicon compounds. Gasoline and RTV (room temperature vulcanizing) engine gasketing material are the two main sources of silicon poisoning.

There is little you can do to guard against silicon in gasoline except to buy from a reputable dealer. If the fuel is contaminated, you won't know it until your engine starts hesitating or missing. In extreme cases, replacing the sensor is the only cure; baked-on silica coats the sensor as if it had been dipped in molten glass.

Servicing is one area where you have more control. RTV is the familiar silicon-based gasket in a tube used by auto makers, service technicians, and backyard mechanics. RTV gaskets are used on engine valve covers, oil pans, and intake manifolds.

Using the wrong RTV during repairs can cause severe sensor poisoning, as the silicon finds its way into the intake manifold and is burned in the engine. Worse still, the engine will poison one sensor after another until the RTV is removed. RTV that's safe for use on engines equipped with oxygen sensors should so state. Check the package.

Even with compounds safe for use with oxygen sensors, apply the material carefully. Don't get sloppy, and don't use more than you need. Also beware of solvents or cleaners containing silicon. Don't use them anywhere they might be drawn into the engine or fuel system.

Diagnosing a bad sensor

Misdiagnosing oxygen-sensor problems is common when working with computer-controlled engines. In fact, misdiagnosis was cited by every manufacturer I interviewed as the number-one reason for sensor replacement. "Most of our returns from the field are the result of diagnostic problems, not sensor failure," said McMackin.

This hasn't been a major expense for consumers to date, as most of the sensors replaced were on 1981 and later models and were therefore covered by the five-year, 50,000-mile emissions-system warranty. But oxygen sensors could become an expensive repair item as warranties expire and car owners begin paying for replacements. Care is needed if you are repairing your own car, and skepticism is called for if a mechanic asks you to pay for a replacement sensor.

Unnecessary replacements occur, in part, because of the closed-loop design of engine control systems. "The oxygen sensor is the last thing in the line," said McMackin. "Every other component in the system is in front of it."

For instance, if the fuel injectors are supplying too much fuel, the oxygen-sensor signal won't cycle properly, said McMackin. "People who blame the sensor are like kings who kill the messenger for bringing bad news."

So the tricky part of diagnosing a sensor is separating cause from effect. Good electrical connections, outside air for the reference side of the sensor, and a high-enough exhaust temperature are prerequisites for the switching action. And many problems can develop in an engine control system that can alter the mixture enough to prevent the oxygen sensor from switching. A methodical approach and a good service manual are called for.

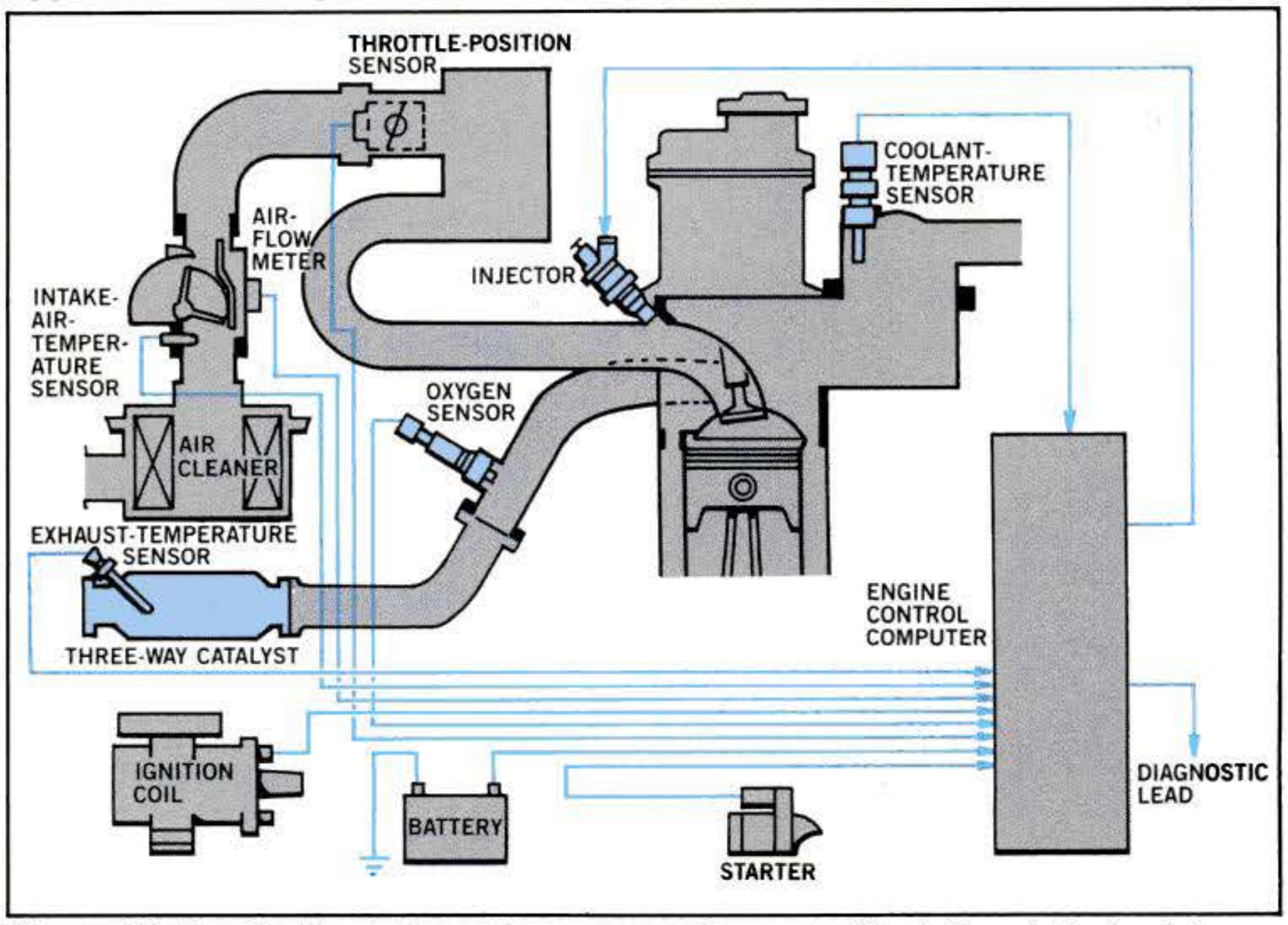
The most common diagnostic sequence involves hooking a voltmeter or dwell meter to a special connector under the hood, then watching for changes as the engine is forced to run lean, then rich. This not only tests the sensor, but the wiring and computer as well. Such procedures are simpler than they sound if you follow the detailed sequence in a factory service manual.

Ford and some other car makers approve of checking sensor output directly by attaching a digital voltmeter (one with an input impedance of 10 megohms or greater) to the sensor lead. But you run the risk of damaging the sensor if you use the improper voltmeter or try to check its resistance. And you still need to know the proper way to force the engine to run rich, then lean, to check output voltage. Otherwise you may overheat the catalytic converter. Again, I recommend reaching for the service manual.

Finally, remember that given good fuel and proper engine maintenance, the oxygen sensor should be about the last thing to check when an engine is running poorly. Just because it's easy to remove and looks like a spark plug, doesn't make it a candidate for the trash can. PS

Kenneth Zino is Editor of Motor Magazine, *a publication for professional auto mechanics.*

Typical fuel injection



By combining feedback from the oxygen sensor with information from other sensors on the engine, a small computer can adjust the air-fuel mixture to keep the engine running smoothly and exhaust emissions at a low level.

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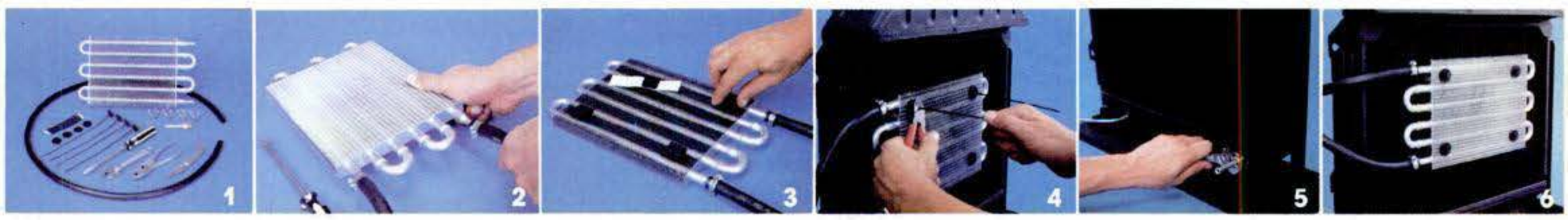
If you delay, you pay. Fact is, over 13 million* transmissions failed last year. Nine out of ten failures were caused by overheating. A small investment in a Hayden Trans-Cooler can save $500 to $1200 on repairs. Remember, each 20°F drop in temperature doubles oil and equipment life.

*Courtesy ATRA (Automatic Transmission Rebuilders Association)

Quick do-it-yourself installation. If you can change the oil in your car you can make this installation yourself.

Free Road Atlas and $5 rebate coupons on the purchase of Hayden Products. Check with your local retailer for details on how to receive a free Rand McNally Road Atlas and Travel Guide. Plus rebate coupons for $5 on the purchase of any Hayden Trans-Cooler, Electric Fan and Thermal Fan Clutch and up to $300 worth of travel discount coupons good nationwide at major motel and amusement centers with your purchase of a Hayden Trans-Cooler.



1. Typical Hayden Trans-Cooler kit with everyday household tools. **2.** Place clamps on end of hose and push hose onto oil cooler fittings. **3.** Attach adhesive cushion pads to oil cooler. **4.** Insert Hayden's patented Quik-Mounts through radiator and cooler. Install locking fastner and cut off excess. **5.** Install Hayden's patented Quick-Connect coupler into radiator. **6.** When completed your Hayden Trans-Cooler installation will look like this.

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Mega Mac

The Apple Mac II could be the first in a new wave of personal computers. Compatible with both the Apple Macintosh and IBM PC, it has megabytes of memory and high-speed processing far in advance of anything available in a personal computer until now.

By JIM SCHEFTER
Photo by Marc Geller

CUPERTINO, CALIF.

It's just ahead," someone said as we walked down the hallway. Our small band of writers and editors approached the door to a room that contained the reason for this clandestine meeting: a supersecret super Mac. I turned the knob, and the door swung open . . . and so did my jaw. I had expected to see an updated facsimile of the old Mac. I wasn't even close.

The Mac II looks more like an IBM PC clone topped with a separate monitor—a 12-inch monochrome or 13-inch color unit. It comes with your choice of two detachable keyboards: an 81-key standard unit or a 105-key model with special keys for MS-DOS, UNIX, or terminal emulation. Inside the box is a 20-, 40-, or 80-megabyte hard disk, expansion slots, and megabytes of internal random-access memory (RAM) with *gigabytes* (billions of bytes) of memory possible. And making it all work is a full 32-bit microprocessor running twice as fast as those in most other desk-top computers. It's a totally new computer for Apple and perhaps the first in a whole new generation of desk-top machines for us.

"What we have is an open Mac that's the pride of our lives," said a beaming Del Yocum, Apple's chief operating officer. An "open" Mac means that Apple now invites other manufacturers to sell circuit boards that plug into the computer's expansion slots for special work. To get things rolling, Apple is offering an MS-DOS board: Plug it in, and the Mac II uses programs written for the IBM PC.

One expansion slot must be used for a video board, but the rest could someday be used for memory. "Standard memory is one megabyte with 256-kilobyte RAM

Continued

Color me new: Apple's Mac II screen has a 640-by-480-pixel resolution. The desk-top box measures 5.5 by 14.7 by 18.7 in.

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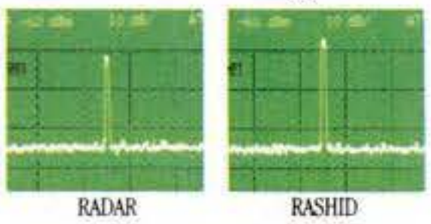
Why Passport is the most expensive* radar detector in the world

What sets Passport above other detectors is the technical reach of our engineers, and their insistence on excellence at every design step. *Road & Track* called us "the industry leader in detector technology." Here's why:

Double-ridge waveguide: It was always taken as gospel that miniaturizing a detector would hurt performance. Passport proved this wrong. The miniaturized horn antenna feeds into a double-ridge waveguide. Dual compound chokes are required, and the notch filters are press fit to exact depth. The design process was incredibly complex. But the payoff is indisputable. Passport's performance is uncompromised by its discreet size.

Rashid rejection: In another engineering first, our detectors have been made immune to K-band signals transmitted by the Rashid VRSS collision warning system. Other detectors produce false alarms in the presence of Rashid. Our AFR™ (Alternating Frequency Rejection) circuitry isolates and neutralizes Rashid signals, yet leaves the radar detection capability undiminished for your protection.



X-K differentiation: Passport has separate warning tones to distinguish X-band from K-band. The difference is important. Traffic radar is just one of many transmitters assigned to X-band by the FCC. Motion detectors, burglar alarms and microwave door openers also share this frequency. When you hear the X-band warning, you respond accordingly.

But just two transmitters operate on K-band — radar and Rashid. K-band radar's short effective range requires immediate response. Since our AFR circuitry rejects Rashid, Passport's K-band warning is positively radar, and you always know how to respond.

Variable-rate warning: On radar contact, Passport's bar graph of eight Hewlett-Packard LEDs indicates radar strength, and you will hear the audible warning — pulsing slowly at first, quicker as you approach, then constant as you near effective radar range. Our engineers have preprogrammed the warning system to tell you everything you need to know about radar. Passport asks no further programming of you, unlike many lesser detectors.

SMD circuitry: Passport's miniaturization was made complete by the use of SMD's (Surface Mounted Devices), micro-electronics common in satellites but long considered too exotic for radar detectors. SMD circuit boards also provide ruggedness unobtainable with conventional technology.

Compact dimensions: Passport was designed to be the most discreet detector ever — only 0.75″ H x 2.75″ W x 4.50″ L. On guard, it never draws attention to itself.

Die-cast aluminum housing: The antenna is integrated into Passport's die-cast SAE 308 aluminum housing. This way no amount of abuse can ever shake the antenna loose, and Passport's precision electronics are protected by a rugged metal vault for durability under extreme conditions.

Nextel finish: The alloy housing is finished in charcoal Nextel — a light-absorbing coating — to eliminate all possibility of reflection and glare.

Twin speakers: A fully adjustable volume control allows you to set the loudness of the audible warning from twin speakers. The warning tone is 1024 Hz, identical to that used for Morse code, for maximum clarity yet minimum annoyance.

All accessories included: Passport comes complete with everything needed for installation in any car, including coiled cord, straight cord, windshield mount bracket, visor mount bracket, hook-and-loop fastener, lighter adapter, direct-wire power adapter, and comprehensive owners manual. A leather travel case is also included.

Satisfaction guaranteed: We engineered Passport, we build it, and we sell direct to you. We take full responsibility for your satisfaction. If you're not completely satisfied within 30 days, return Passport. We'll refund all your money, including postage.

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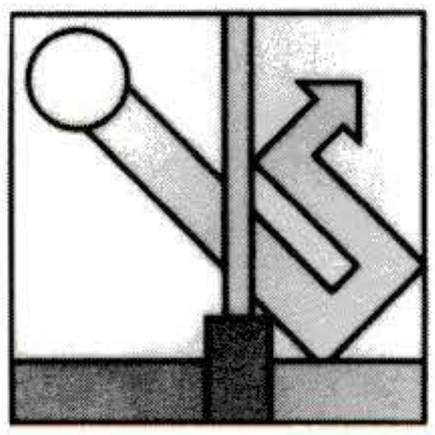

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chips installed in one of two memory banks," Yocum said. Filling the second bank increases RAM to two megabytes, but that's only the start. Apple designed Mac II to accept the newest high-density memory chips for up to eight megabytes of RAM. And with future chips—available sometime in the 1990s—Mac II is ready to jump to 128 megabytes. "The five remaining expansion slots could be used for memory boards," Yocum continued. "That pushes the maximum RAM beyond two gigabytes." (Of course, I suspect that *managing* that amount of memory—from error detection to operational speed—will take more than just plug-and-go simplicity.)

To make large arrays of memory useful, the computer must work quickly. Mac II's microprocessor—the new Motorola 68020—addresses and processes data in 32-bit chunks (other micros work with 8 or 16 bits at a time). It runs at a 16-megahertz clock speed (others are usually about 8 MHz) and directly controls up to 128 megabytes of RAM. Also, a built-in math co-processor, Motorola's 68881 floating-point device, increases arithmetical speed up to 200 times over existing personal computers.

High speed . . . large memory . . . an assortment of add-ons. They're all fine ideas, but to me the true test of the Mac II was to come: I would try it.

Compatible?

Is the Mac II compatible with all programs written for my regular Mac? To find out, I brought some of my own to try, and in a few minutes I had my answer: No.

MacPaint can't use the full-size Mac II monitor screens. The program runs twice as fast as on current Macs but fills only the same amount of screen. "A small number of software packages are in the same category," said Didier Diaz, Mac II's project manager. A few won't run at all.

"The problem," Diaz told me, "focuses on how the software uses the screen." Apple will have a new version of MacPaint, and it will provide instructions on how to modify other programs to use the larger Mac II screens. However, most programs, including Excel, Word, More, and OverVue packages, take full advantage of the increased screen size. For instance, four documents can be opened at once in Microsoft Word, with each window large enough to be useful without resizing.

Current Mac software is monochrome, but new versions of existing packages, along with all-new software, undoubtedly will take advantage of Mac II's color, particularly for chart and graph functions. But the real benefit of Mac II is speed. I tried an OverVue data base with 106 records. It scrolled top to bottom in 3.4 seconds on Mac II, versus 10.5 seconds on my older Mac. Similarly, search-and-replace functions and re-pagination in Microsoft Word (version 1.05) took about one-fourth as long.

New generation?

Industry experts already call the Mac II a breakthrough in desk-top computing. "It's a new generation," says Michael Slade, group program manager for Macintosh applications at Microsoft Corp. (Bellevue, Wash.).

Ashok T. Jain, vice president of AST Research, Inc., in Irvine, Calif., a developer of add-on boards and peripherals for personal computers, agrees: "It's more powerful than any personal computer," he says. "It should be called a work station."

Until now, the term had been reserved for machines devoted to engineering design applications, usually based on minicomputers. Minicomputers—which cost tens of thousand of dollars—are considered to be just a step down from the power and speed of a large main-frame computer. To the computer purist, a personal computer—a microcomputer—was considered a far distant cousin.

Attaching minicomputer work-station capabilities to the Mac II computer means an increase in speed and capabilities for all applications. For example, integrated programs, which today seldom combine more than four functions, could easily include dozens. And separate programs, now used mostly one at a time, could all share memory and be used simultaneously without any appreciable decrease in speed.

A new generation of computers will mean new peripherals, too. For example, SuperMac Technology, a firm based in Mountain View, Calif., has an enhanced display system for Mac II ready to go. "The system turns Mac II into an engineering work station equal to minicomputer stations costing seven times as much," claims project manager Tom Reilly. For desk-top publishing, a super-high-resolution video board and a 19-inch color monitor display two pages of text on the screen at once, and up to 256 colors can be used simultaneously.

The price of the Mac II will be about $5,400 for a basic unit with a color monitor—more than $6,000 for a machine with a floppy disk, internal hard disk, and additional memory. Not bad, considering those are microcomputer prices for a machine with minicomputer capabilities. PS

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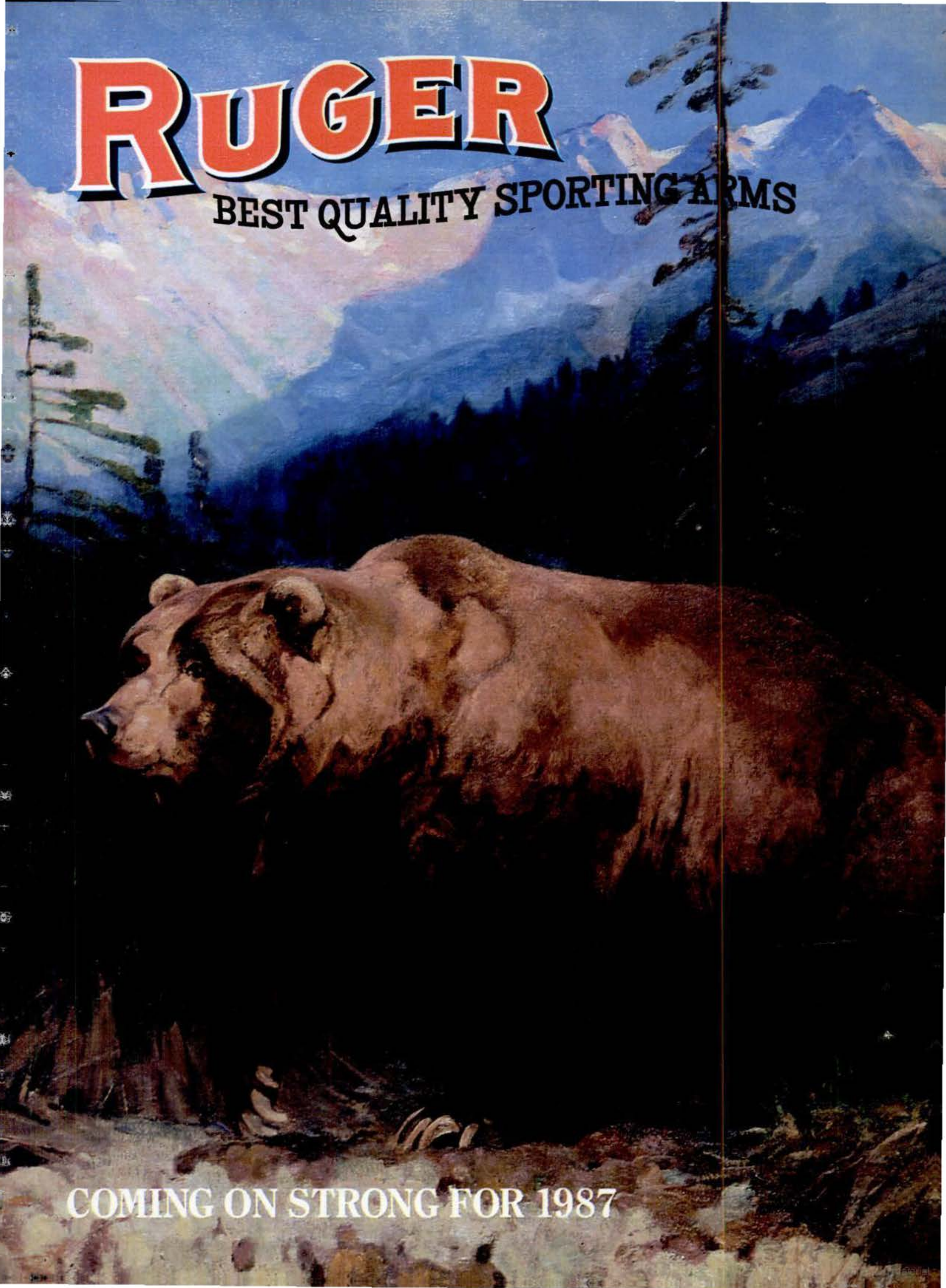
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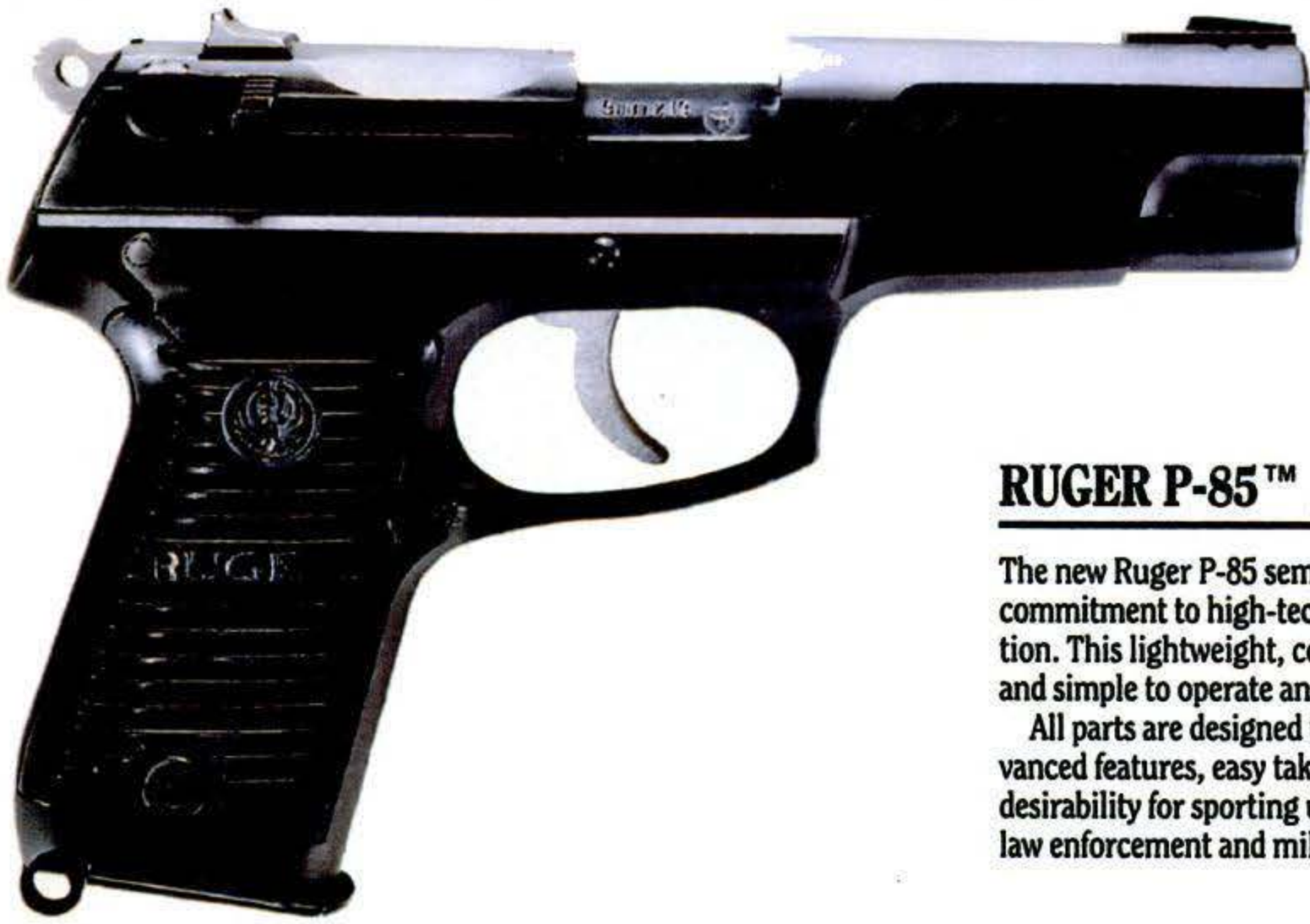


NEW

RUGER P-85™ AUTOMATIC PISTOL

The new Ruger P-85 semi-automatic pistol is the end product of a Ruger commitment to high-tech engineering and the relentless pursuit of perfection. This lightweight, compact, 15-shot, 9mm, double-action auto is reliable and simple to operate and maintain.

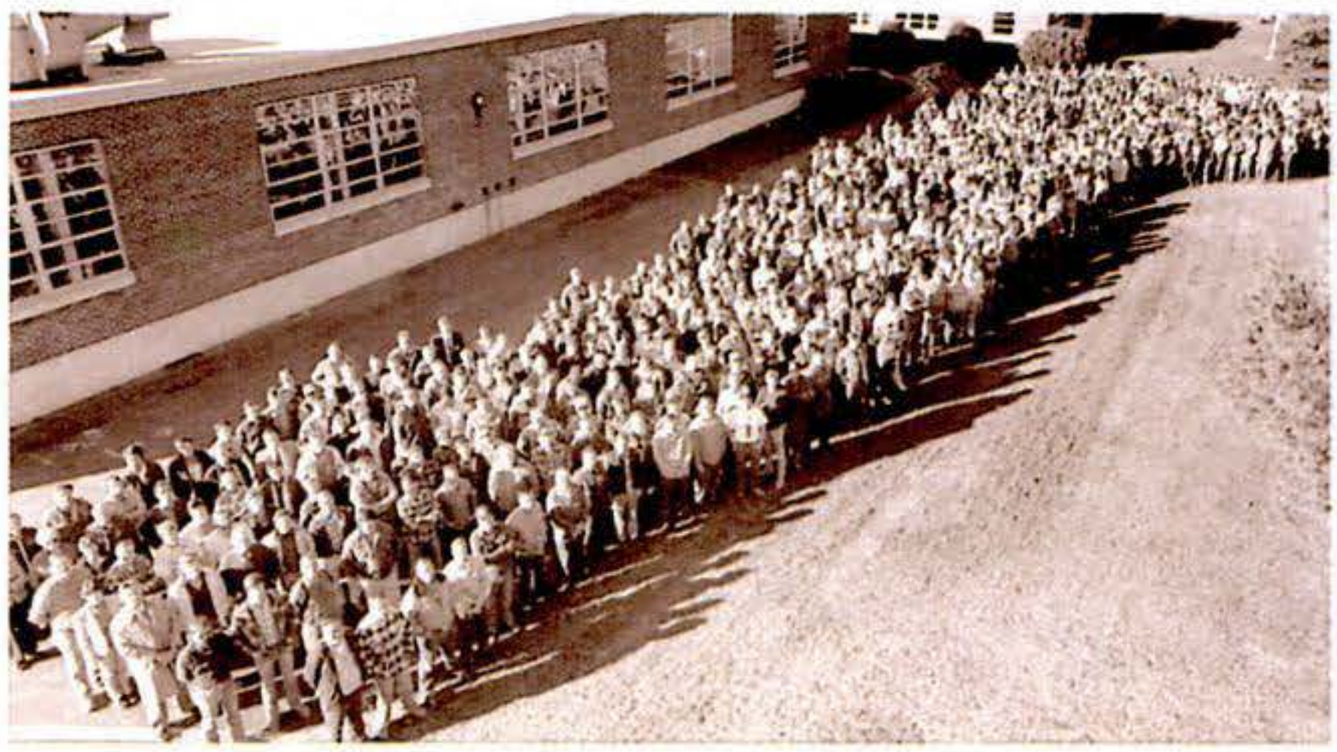
All parts are designed to meet or exceed U.S. Military specifications. Its advanced features, easy takedown, accuracy and reliability all contribute to its desirability for sporting use, competitive shooting, personal defense and as a law enforcement and military sidearm.

RUGER EMPLOYEES PRODUCE ANOTHER ONE-MILLION PRODUCT

The one millionth Ruger M-77 joins the ranks of five other Ruger guns which have already taken their place in sporting arms history by exceeding the one millionth mark. The other million "plus" Ruger guns are: the Ruger "old model" single-action revolver (1970); the Ruger Model 10/22 autoloading carbine (1978); the Standard and Mark I semi-automatic rimfire pistol (1979); the Ruger "New Model" single-action revolver (1979); and, the Ruger double-action revolver in Security-Six, Service-Six, and Speed-Six models (1983).

The company has achieved this singular acceptance in its field in less than forty years with a reputation for producing finely conceived firearms with an unparalleled record of quality control, safety, and reliability in the field at a fair price.

A large percentage of Ruger sporting arms are sold through the specialty gun dealer who provides expertise and "personal service" in the day-to-day business of meeting the requirements of the hunting, shooting, and law enforcement communities. Many of these dealers are listed in the Yellow Pages under headings such as *Guns*, *Gunsmiths*, and *Sporting Goods*. To experience the genuine pleasure that comes from handling fine quality Ruger firearms, visit and support your independent stocking gun dealer.



"We're coming on strong" at the Ruger plant in Newport, New Hampshire, as seen in this photo which shows approximately 800 of the more than 1500 quality-conscious people who are employed in five Ruger manufacturing facilities across the country. All of us at Ruger are dedicated to manufacturing sporting guns of the highest quality, strength and reliability. Every Ruger firearm is tested by actual shooting on our ranges before shipping.

ABOUT OUR COVER . . . ABOUT CONSERVATION . . . ABOUT SPORTSMEN . . .

To many sportsmen our cover painting, *Alaskan Brown Bear Out of the Shadows* by one of North America's greatest game-animal artists, Carl Rungius (1869-1959), exemplifies the objectives of the Pittman-Robertson Federal Aid in Wildlife Restoration Act which marks its fiftieth anniversary in 1987.

Much of the wilderness and its wildlife inhabitants as seen through Mr. Rungius' eyes has been restored as a result of the successful implementation of Pittman-Robertson. This unique program in which *hunters pay for conservation* and hunter safety education is funded by a federal excise tax on firearms, ammunition and archery equipment. Since its inception Pittman-Robertson has provided the impetus for the preservation and perpetuation of vast populations of game birds and animals, particularly of those many species once thought to be extinct. The success of this program is a tribute to the millions of knowledgeable hunters who have helped make it possible.

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RUGER® SINGLE-ACTION REVOLVERS

RUGER® BISLEY SINGLE-ACTION REVOLVERS

Ruger's Bisley mates a target shooting tradition with a modernized version of the Bisley grip shape to suit the most discriminating marksman. Offered in two frame sizes with roll engraved, non-fluted cylinders. Chambered for a variety of handgun cartridges for target shooting and hunting.

Stainless steel model.

New Model Super Single-Six

New Model Single-Six .32 H&R

NEW MODEL SUPER SINGLE-SIX® & .32 H&R REVOLVERS

The Ruger Single-Six was introduced over three decades ago and remains one of the most coveted single-actions. The patented Ruger transfer-bar ignition mechanism and other refinements have been features of New Models since 1973.

Originally chambered for the .22 Long Rifle Cartridge, the Single-Six is now offered in the new .32 H&R Magnum caliber, a hard-hitting small game, varmint and target load.

New Model Blackhawk

New Model Super Blackhawk

Stainless steel model.

NEW MODEL BLACKHAWK® & SUPER BLACKHAWK® REVOLVERS

Ruger Blackhawk revolvers are expressly engineered for use with powerful modern centerfire cartridges. They incorporate all the best features of the Ruger New Model centerfire single-action design, including the transfer bar ignition mechanism.

The simplicity and dependability of our single-action revolver is legendary among outdoorsmen. Available in: .30 Carbine, .38 Special, .357 Mag., .41 Mag., .44 Mag. and .45 Long Colt.

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RUGER®

NEW

Shown Actual Size

Service-Six

Stainless steel model.
Goncalo Alves grips.

Speed-Six

Stainless steel model.

RUGER SERVICE-SIX® AND SPEED-SIX® REVOLVERS

These two Ruger double-action revolvers are reliable, durable, and perfectly mated to the .357 Magnum and .38 Special cartridges.

Over one million of these revolvers in this series have been made for use by sportsmen and the law enforcement community around the world. Available in blued steel and stainless steel, with 2 ¾" and 4" barrels, and Goncalo Alves wood or rubber grip panels.

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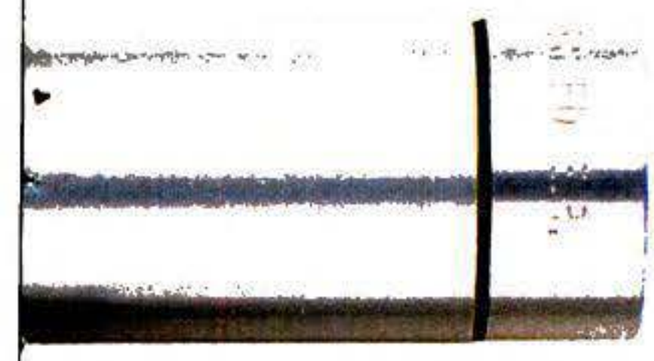
NEW GENERATION DOUBLE-ACTION REVOLVERS FOR HUNTING AND PERSONAL PROTECTION

RUGER SUPER REDHAWK™ DOUBLE-ACTION REVOLVER

The Super Redhawk is seen as the ultimate development in a heavy frame .44 Magnum double-action revolver of unusual appeal for today's hunter and metallic silhouette shooter. It has all the mechanical features and patented improvements of Ruger's newest double-action revolvers. Unique new Ruger Cushioned Grip panels are anatomically designed to fit the hands of a majority of shooters.

The extended frame is designed to accommodate the Ruger Integral Scope Mounting System which positions the scope rearward for superior balance and performance. Interchangeable front sight system. Offered in stainless steel in a variety of barrel lengths.



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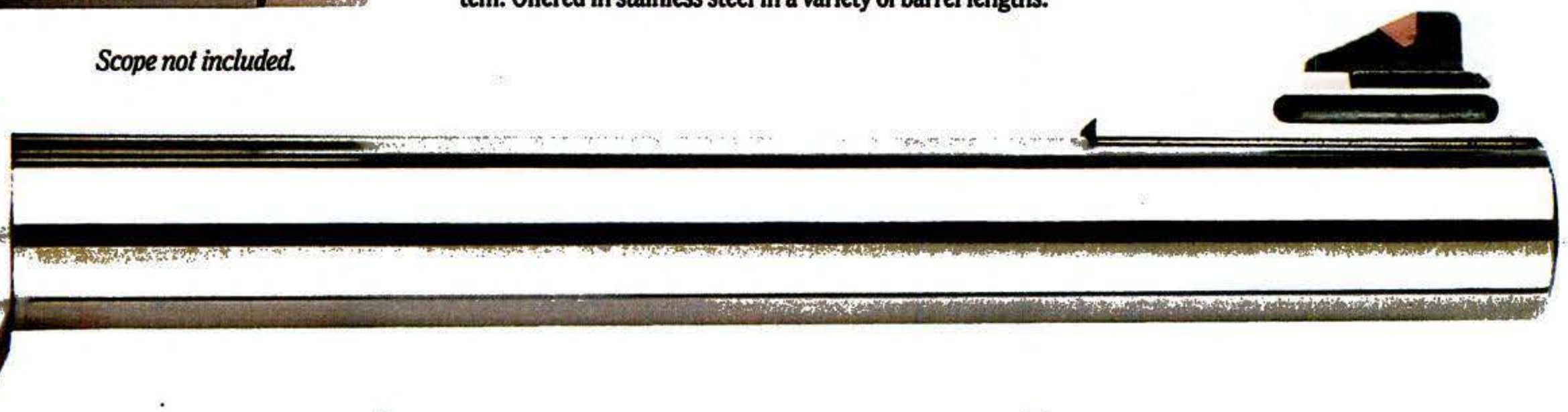
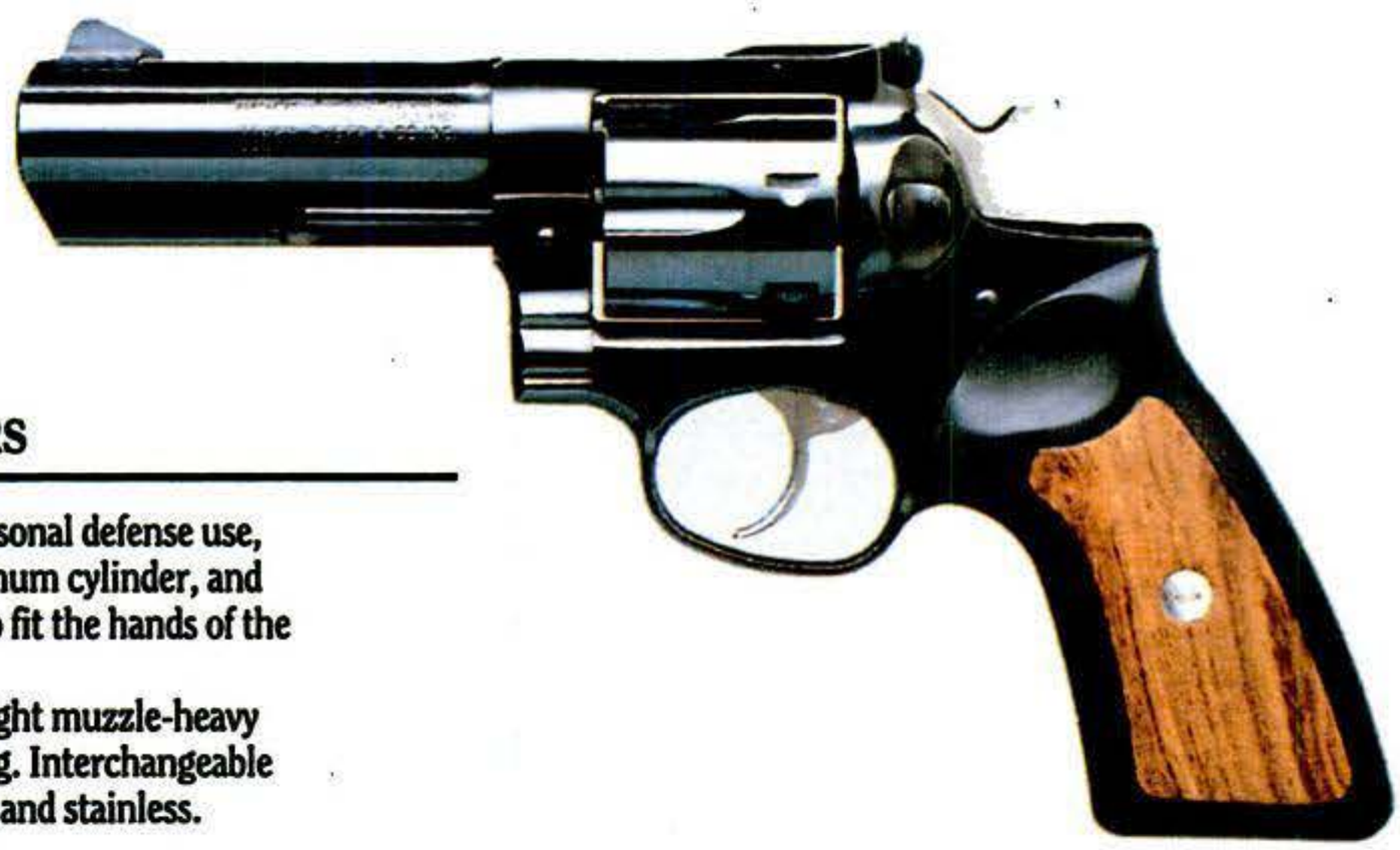


Stainless steel model.

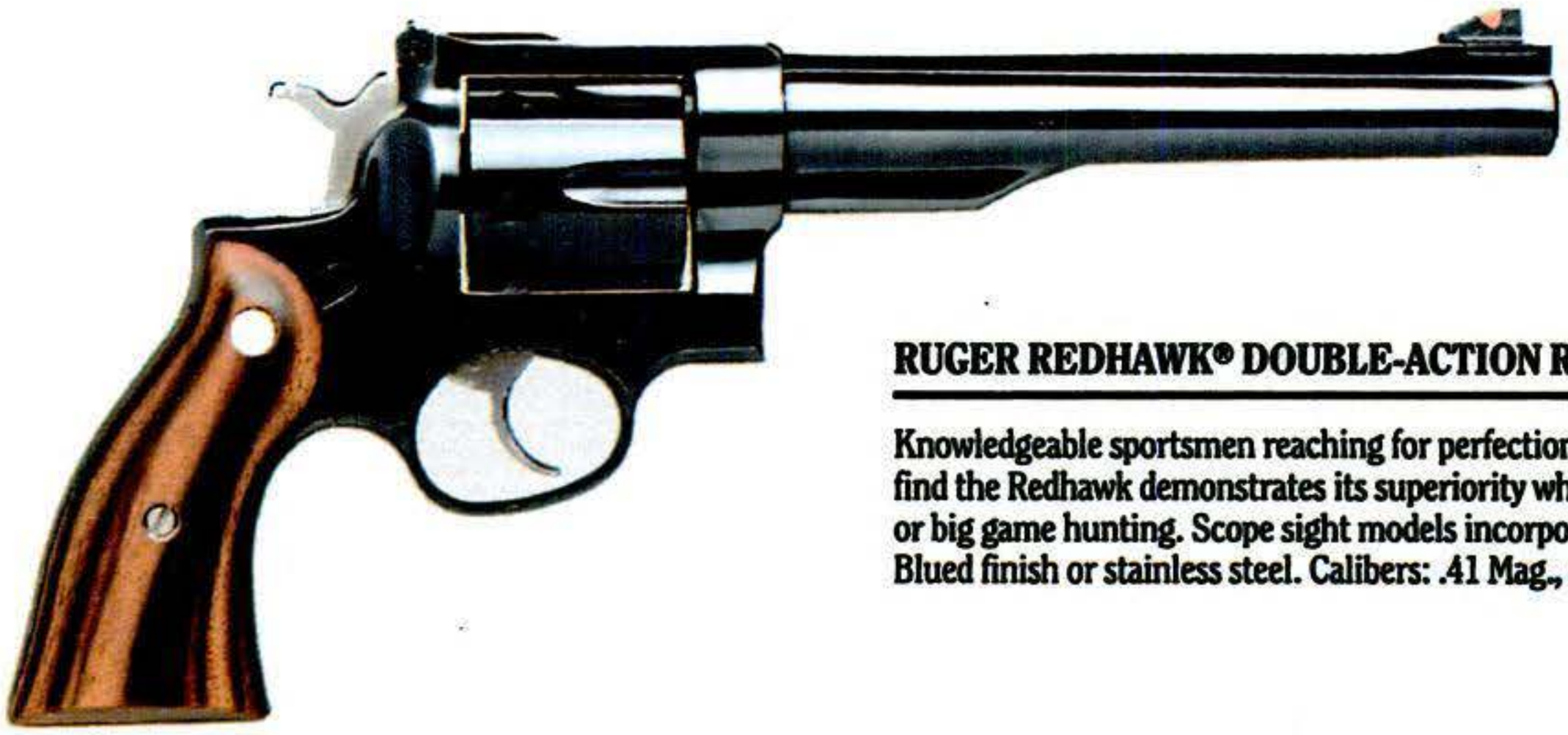
NEW



RUGER GP 100™ DOUBLE-ACTION REVOLVERS

Designed as the ultimate .357 Magnum for police and personal defense use, the new GP 100 includes a heavy frame, rugged .357 Magnum cylinder, and cushioned grip panels which are anatomically designed to fit the hands of the majority of shooters.

A full length ejector rod shroud helps to achieve the slight muzzle-heavy balance considered desirable for rapid double-action firing. Interchangeable front sight system. Available with 4" and 6" barrels, blued and stainless.



RUGER REDHAWK® DOUBLE-ACTION REVOLVERS

Knowledgeable sportsmen reaching for perfection in a big bore handgun will find the Redhawk demonstrates its superiority whether silhouette shooting or big game hunting. Scope sight models incorporate bases for Ruger rings. Blued finish or stainless steel. Calibers: .41 Mag., and .44 Mag.

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RUGER® RIFLES, CARBINES & SHOTGUNS

NEW

Scope not included.

RUGER MINI THIRTY™ SEMI-AUTOMATIC RIFLE

Ruger's new Mini Thirty chambered for the 7.62 x 39mm cartridge is destined to become one of America's most popular deer rifles. This lightweight, compact new sporter (approximately the same size as the Mini-14) is ideal for hunting whitetail and other medium size game in heavy cover. Designed with Ruger Integral Scope Mounts for telescopic sights. One inch Ruger rings included.

Scope not included.

Ranch Rifle

RUGER MINI-14® AND RANCH RIFLE®

The Mini-14 and Ruger Ranch Rifle (illustrated) are rugged, easy handling, lightweight semi-automatics. The Ranch Rifle is designed for use with telescopic sights. Both the Mini-14 and Ranch Rifle are available in full and folding stock models that are ideal for camping and boating. Offered in blued alloy and stainless steel. Caliber: .223 Rem.

Scope not included.

RUGER 77/22™ RIMFIRE BOLT-ACTION RIFLE

The new Ruger .22 rimfire bolt-action is an elegant small game and target rifle. Unique new 3-position safety offers a new dimension in security. Ruger 10-shot rotary magazine provides smooth feeding. Receiver with integral scope bases accommodate Ruger rings.

RUGER 10/22® AUTOLOADING CARBINE

The Ruger 10/22 offers light weight, short overall length, and mechanical dependability. A 10-shot rotary magazine handles .22 Long Rifle cartridges. The reliable Ruger 10/22 is an excellent choice for small game hunters, target practice or plinking. Standard model or Deluxe Sporter offered.

RUGER® "RED LABEL" OVER & UNDER SHOTGUNS

A precision-engineered and manufactured shotgun of exceptional value and quality. Excellent balance and superb swing provide superior over and under performance. Offered with 3" chambers in 12 and 20 gauge with 26" or 28" barrels in standard choke combinations.

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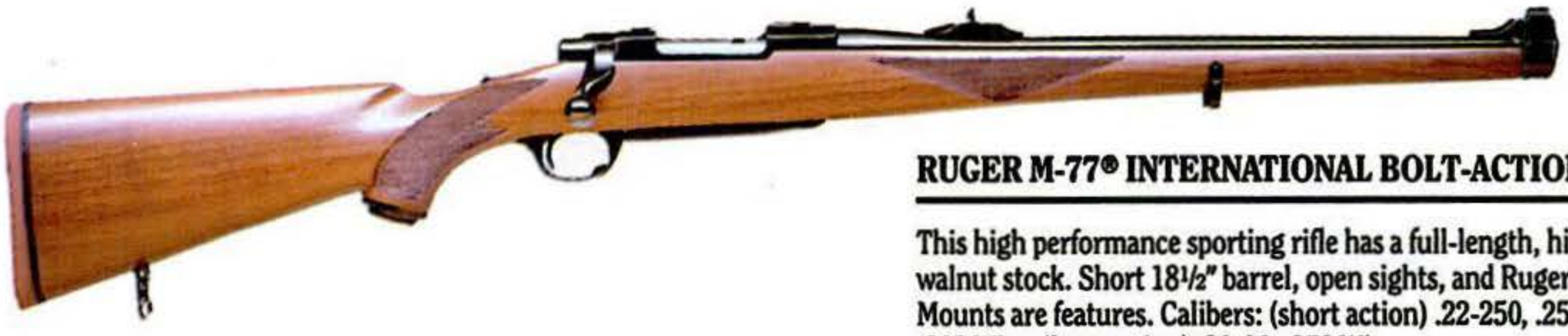
RUGER M-77® BOLT-ACTION RIFLE

Prized as a trophy rifle, this versatile bolt-action is used to hunt all sizes and species of game. Receivers incorporate integral scope bases that accommodate Ruger rings. Available in both magnum and short actions in calibers ranging from .22-250 to .458 Mag.



RUGER M-77® INTERNATIONAL BOLT-ACTION RIFLE

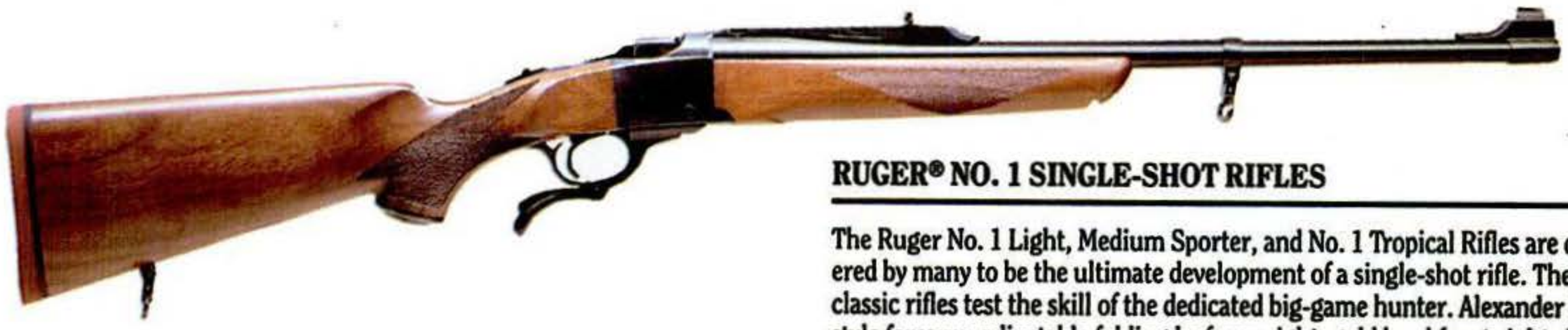
This high performance sporting rifle has a full-length, high grade American walnut stock. Short 18½" barrel, open sights, and Ruger Integral Scope Mounts are features. Calibers: (short action) .22-250, .250-3000, .243 and .308 Win., (long action) .30-06, .270 Win.

Scope not included.

NEW

RUGER M-77® ULTRA LIGHT BOLT-ACTION CARBINE

Weighing in at just 6 pounds this easy-to-handle carbine encompasses all of the traditional features and craftsmanship that have made the Ruger M-77 one of the most popular hunting rifles in the world. Short 18½" barrel with iron sights. Chamberings include magnum and short action calibers: .270 Win., .30-06, .243 and .308.

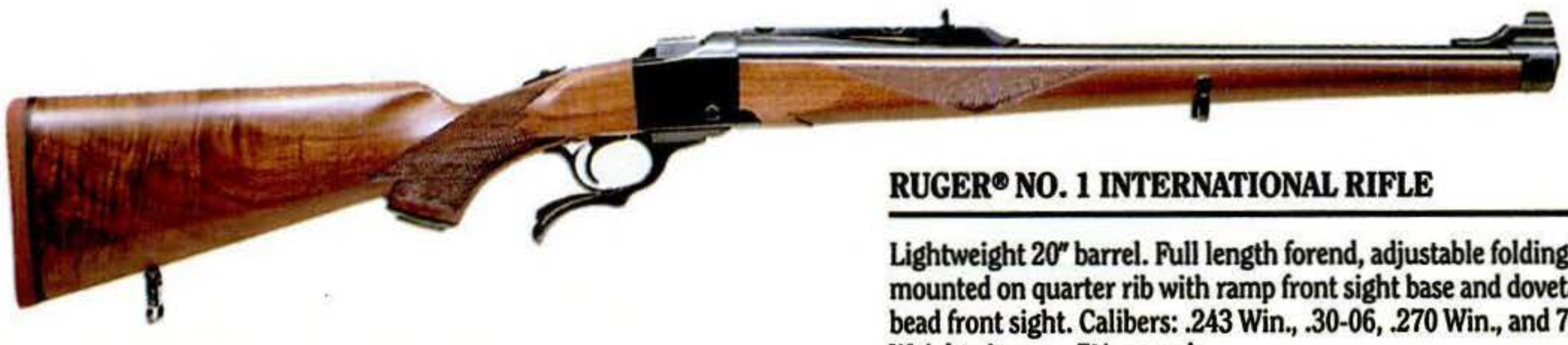


RUGER® NO. 1 SINGLE-SHOT RIFLES

The Ruger No. 1 Light, Medium Sporter, and No. 1 Tropical Rifles are considered by many to be the ultimate development of a single-shot rifle. These classic rifles test the skill of the dedicated big-game hunter. Alexander Henry style forearm, adjustable folding leaf rear sight, gold bead front sight. Available in a range of calibers, barrel lengths and weights.

RUGER® NO. 1 STANDARD AND SPECIAL VARMINTER RIFLES

Standard model has a medium 26" barrel, semi-beavertail forearm, quarter rib with one inch Ruger rings. Varmint model with heavy 24" barrel is tapped for target scope blocks, one inch Ruger rings included. Available in a variety of sporting and varmint calibers.



RUGER® NO. 1 INTERNATIONAL RIFLE

Lightweight 20" barrel. Full length forend, adjustable folding leaf rear sight mounted on quarter rib with ramp front sight base and dovetail type gold bead front sight. Calibers: .243 Win., .30-06, .270 Win., and 7 x 57mm. Weight: Approx. 7¼ pounds.

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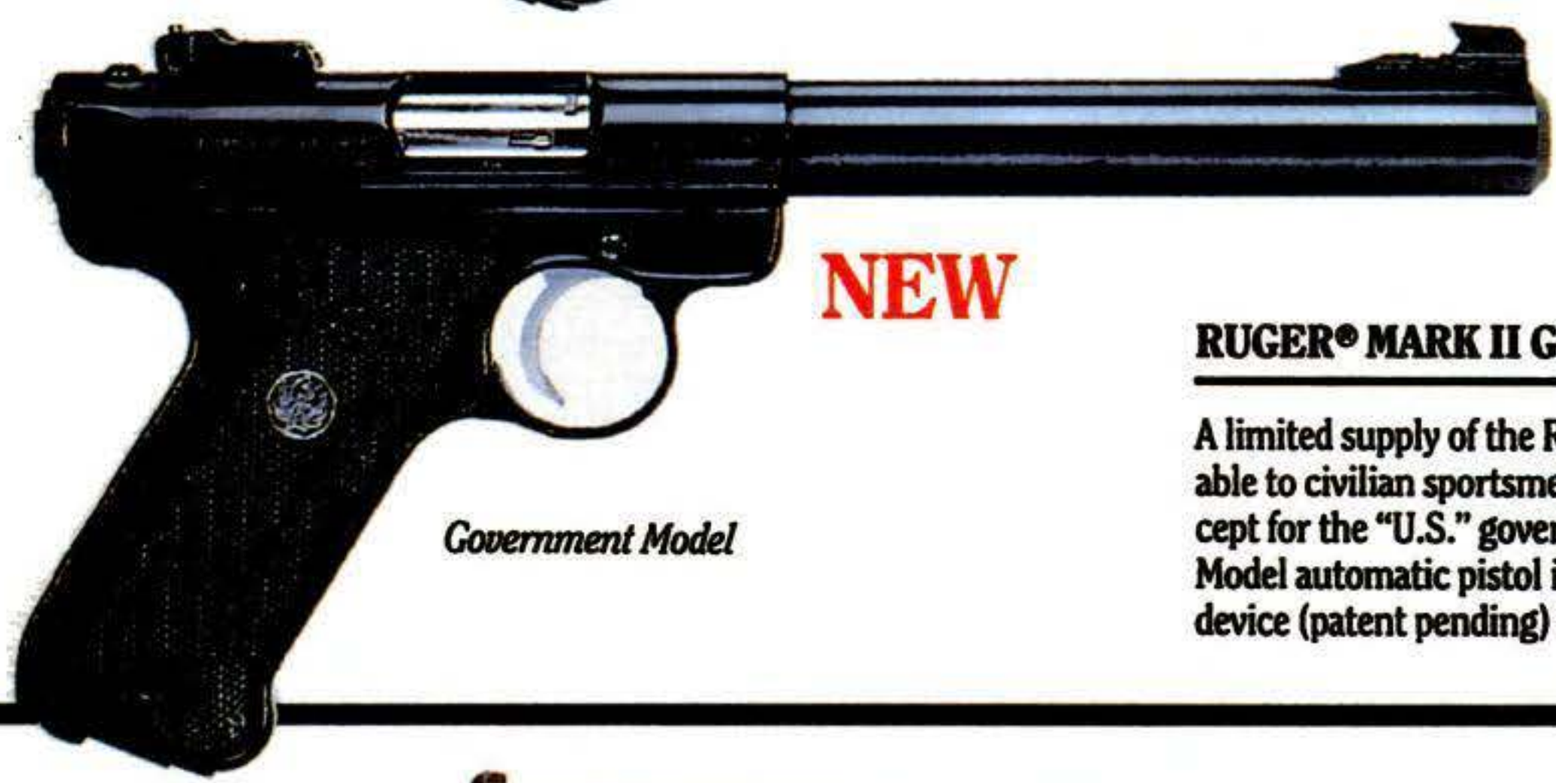

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Versatile van from Japan

A mid-mounted four-cylinder engine drives the Mitsubishi Wagon's rear wheels. Seating for seven is flexible: Captain's seats swivel 360°. The rear bench seat has folding central armrest; it's removable for extra cargo space.

Booming compact-van sales have been a bright spot for car manufacturers lucky enough to have such a vehicle to sell—and a source of chagrin to those that haven't. Mitsubishi found itself on both sides of this situation. The Japanese maker builds the Vista van, a successful seller in Chrysler dealerships, but unfortunately for Mitsubishi dealers, it is a Chrysler exclusive. Now Mitsubishi thinks it has remedied that vexing problem by introducing a new van with streamlined looks and a unique seating system.

I recently spent several days driving the new Mitsubishi Wagon over hilly roads east of San Diego and along stretches of interstate paralleling the Pacific. I also had an opportunity to test Mitsubishi's companion windowless cargo Van—a version designed for commercial users and consumers who want to do their own conversions.

The van is powered by a 2.4-liter inline four-cylinder engine with multipoint fuel injection, which the company claims is the most powerful in the import-van class. The engine is rated at 107 horsepower. The only transmission offered is a four-speed automatic with overdrive lockout control. This power train produced adequate pep for climbing even the steepest hills I encountered—and without feeling that the engine was straining. Acceleration was also adequate for this type of vehicle—even with a heavy load.

The new Wagon isn't exactly a sports car, but handling is crisp and cornering is accomplished without a great deal of body roll. I didn't perform any formal braking tests, but stopping appeared to be adequate without any hint of fade—even after hours of driving over mountainous terrain.

The driver's seat is comfortable, and the instrument panel is convenient and easy to read. Getting in and out of the vehicle is a snap for both driver and passengers. Stashing cargo in the rear is easy because of the lift-up hatch door in back. For really big loads you can remove the rear seat. Taking out that rear seat is probably a good idea in most instances because, unless you must have the seating space, I found that it's not a comfortable place to sit. Since the seat is mounted over the rear axle, you tend to bounce up and down constantly when the Wagon is in motion.

Base price for the Wagon is $12,789. An LS version with many power accessories costs $14,289. The base cargo Van is $9,839; a model with an optional converter convenience package is $10,529.—*Herb Shuldiner*

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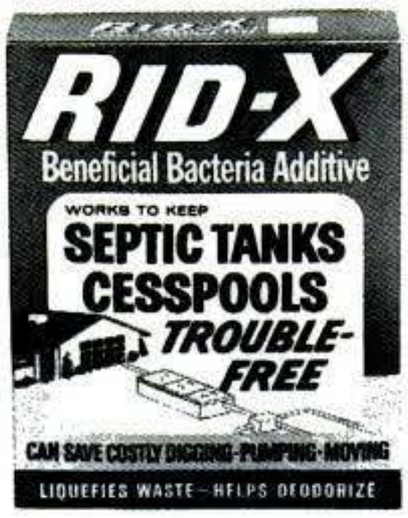
The alternative to waiting around for your septic system to back up



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Light-bulb savers: not a bright idea

Alexander Emanuel saw an ad for something called a light-bulb saver—a device that promised to extend bulb life and save energy—and ordered a few. But Emanuel, a professor of electrical engineering at Worcester Polytechnic Institute (Worcester, Mass.), had more in mind than saving energy.

A light-bulb saver, a silicon diode in a disc-shaped casing, is attached to a bulb's base inside the socket. Normally, power-line current flows through a lamp in alternating directions. The diode lets current flow in only one direction, reducing voltage across the bulb by 30 percent.

Lowering voltage by that amount cuts power consumption in half. And it increases bulb life—theoretically by about 90 times. But Emanuel says it also does other things that make the trade-off unacceptable.

One problem: current flowing in only one direction injects a component of direct current into the household AC supply. Large numbers of the diodes could generate a bias current across transmission-line transformers, shortening the life of such units. The DC components can also corrode ground electrodes. That can impair the home's protection from lightning and allow high voltage peaks that could damage computers, VCRs, and other electrical appliances.

Another problem: Lowering voltage across the bulb lowers the temperature of the filament by about 750 degrees. "The filament is no longer white hot; it's red hot," Emanuel says. That gives the light red hues. Furthermore, the 50-percent cut in energy cuts the light output by a whopping 70 percent. To get back to the original light, you'd have to add wattage until you were actually using 30 percent *more* energy than originally.

For these reasons, says Emanuel, bulb savers just aren't worth it. And, he points out, there are easier ways to get the same results without the problems. Long-life bulbs, for example, rated at 1,000, 2,000, or even 5,000 hours, have heavier filaments and sacrifice light output for longer life—just as bulb savers do. Also, Emanuel suggests, you can simply buy a bulb rated for a higher voltage than your power-line supplies. It will give a dim light that will last for many years—with no problems. Emanuel's paper in the *IEEE Transactions* received the 1986 award for the best paper published in the engineering journal.—*Dawn Stover*

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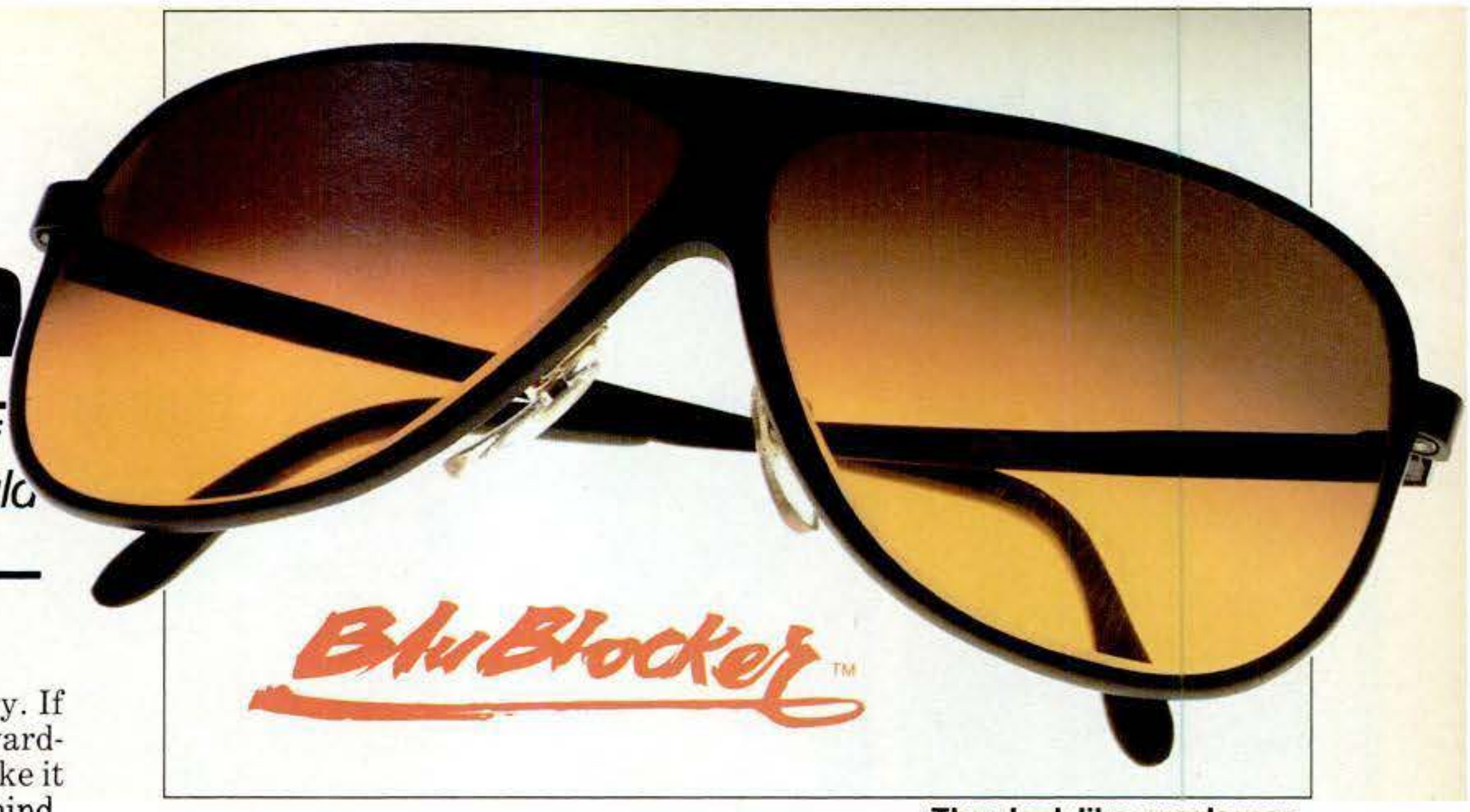
Vision Break-through

When I put on the pair of glasses what I saw I could not believe. Nor will you.



They look like sunglasses.

By Joseph Sugarman

I am about to tell you a true story. If you believe me, you will be well rewarded. If you don't believe me, I will make it worth your while to change your mind. Let me explain.

Len is a friend of mine who has an eye for good products. One day he called excited about a pair of sunglasses he owned. "It's so incredible," he said, "when you first look through a pair, you won't believe it."

"What will I see?" I asked. "What could be so incredible?"

Len continued, "When you put on these glasses, your vision improves. Objects appear sharper, more defined. Everything takes on an enhanced 3-D effect. And it's not my imagination. I just want you to see for yourself."

COULDN'T BELIEVE EYES

When I received the sunglasses and put them on I couldn't believe my eyes. I kept taking them off and putting them on to see if indeed what I was seeing was indeed actually sharper or if my imagination was playing tricks on me. But my vision improved. It was obvious. I kept putting on my cherished $100 pair of sunglasses and comparing them. They didn't compare. I was very impressed. Everything appeared sharper, more defined and indeed had a greater three dimensional look to it. But what did this product do that made my vision so much better? I found out.

The sunglasses (called BluBlockers) filter out the ultraviolet and blue spectrum light waves from the sun. You've often heard the color blue used for expressions of bad moods such as "blue Monday" or "I have the blues." Apparently, the color blue, for centuries, has been considered a rather depressing color.

For eyesight, blue is not a good color too. There are several reasons. First, the blue rays have one of the shortest wavelengths in the visible spectrum (red is the longest). As a result, the color blue will focus slightly in front of the retina which is the "focusing screen" in your eye. By blocking the blue from the sunlight through a special filtration process, and only letting those rays through that indeed focus clearly on the retina, objects appear to be sharper and clearer.

The second reason is even more impressive. It is harmful to have ultra-violet rays fall on our eyes. Recognized as bad for skin, UV light is worse for eyes and is believed to play a role in many of today's eye diseases. In addition, people with contact lenses are at greater risk because contacts tend to magnify the light thus increasing the sun's harmful effects.

SUNGLASS DANGER

Finally, by eliminating the blue and UV light during the day, your night vision improves. The purple pigment in your eye, called Rhodopsin, is affected by blue and ultraviolet light and the eyes can take hours to recover from the damage.

But what really surprised me was the danger in conventional sunglasses. Our pupils close in bright light to limit the light entering the eye and open wider at night like the lens of an automatic camera. So when we put on sunglasses, although we reduce the amount of light that enters our eyes, our pupils open wider and we allow more of the harmful blue and ultraviolet light into our eyes.

DON'T BE CONFUSED

I'm often asked by people who read this, "Do those Blu-Blockers really work?" They really do and please give me the opportunity to prove it. I guarantee each pair of BluBlockers to perform exactly as I described.

BluBlocker sunglasses use ophthalmic-quality CR-39 lenses with a hard anti-scratch coating. Over 85 percent of all doctors' prescriptions are now filled with CR-39. I have taken no shortcuts.

The black, light-weight anodized aluminum frame is one of the most comfortable I have ever worn and compares with many of the $200 pairs you can buy from France or Italy.

The weakest link in any pair of glasses is the hinge. So I have designed a screwless precision two-way tension hinge that not only bends when you close the pair, but is spring-loaded to bend outward too. You get a completely flexible frame that will comfortably contour to your face.

I also have two other exciting models. One is a clip-on pair that weighs less than one ounce and fits over prescription lenses and the second is a precision-molded plastic frame that looks identical to the aluminum model but without the tension hinge. All models include a padded carrying case and my personal one-year no nonsense limited warranty.

I urge you to order a pair and experience your improved vision. Then take your old sunglasses and compare them to the BluBlocker sunglasses. See how much clearer and sharper objects appear with the BluBlocker pair. And see if your night vision doesn't improve as a direct result. If you don't see a dramatic difference in your vision—one so noticeable that you can tell immediately, then send them back anytime within 30 days and I will send you a prompt and courteous refund.

DRAMATIC DIFFERENCE

But from what I've personally witnessed, once you wear a pair, there will be no way you'll want to return it.

Pilots, golfers, hunters, athletes and anyone who spends a great deal of time in the sun, who drives a car or who just wants to protect their vision—all will find BluBlocker sunglasses indispensable.

Our eyes are very important to us. Protect them and at the same time improve your vision with the most incredible breakthrough in sunglasses since they were first introduced. Order a pair or two at no obligation, today.

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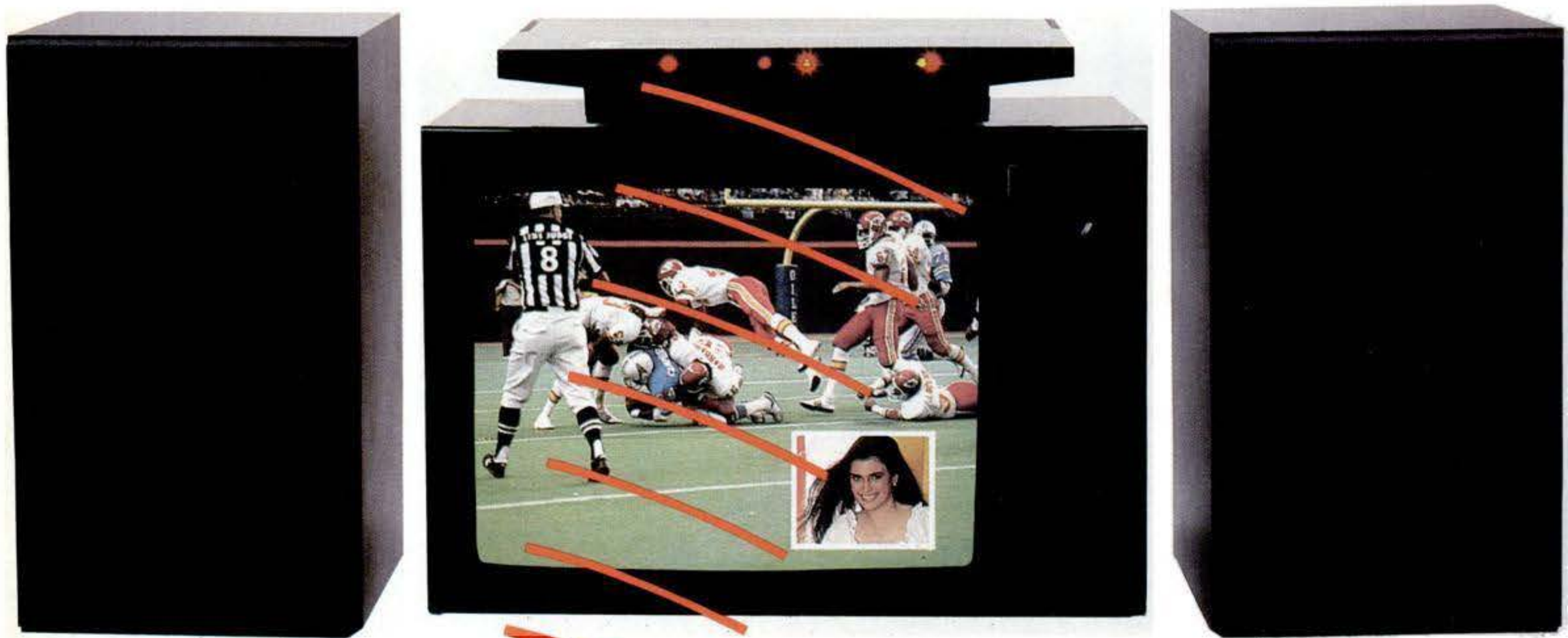

This clever device adds stereo sound, remote control, and digital special effects like freeze frame and picture-in-a-picture to any television set.

By WILLIAM J. HAWKINS
Photos by Greg Sharko

"It's not really magic," said a smiling David Pava, vice president of MultiVision Products, as he attached a single coaxial cable from the black-acrylic MultiVision box to my old TV set. "But I'm about to make your ten-year-old TV work like one of the new digital models."

Two-channel viewing with picture-in-a-picture (PIP)? Stop-action freeze frame? Stereo sound? Wireless remote control? From *my* TV? Pava stepped back and pressed the "on" button on MultiVision's infrared remote control. The TV snapped to life, displaying its 19-inch color picture.

"Now for PIP," said Pava, and he pressed on the remote again. A second picture appeared instantly in the lower right corner. "You can swap scenes between the big and small pictures, and you can move the small picture anywhere," he said as his fingers began manipulating more buttons. "Watch this." The small inset picture hopped around the screen, corner to corner and in towards the center. Then it grew larger, shrunk smaller, and finally froze perfectly still. "That scene can be held there as long as you like for a careful look at sports action, stock quotes, and weather reports."

Pava is no magician but a co-founder in a company that began by creating a new integrated circuit chip that combines two video images. Inside the MultiVision box, the chip is coupled to two 139-channel cable-ready tuners. "The remote control lets you select any channel on either tuner," Pava told me. "One channel is used for the main image. The other is for the small inset picture." The two pictures combined into one let you watch one show and check another.

MultiVision works with any TV, but I was particularly impressed by the way it handles more complicated setups. For example, a special connector is for a cable descrambler box. If the descrambler is needed for seeing a premium show (like HBO), it can be selected by pressing an "aux"—auxiliary—button on the remote control. For stereo reception, it has a built-in MTS stereo decoder.

I also tried MultiVision with my audio-video system. Fantastic. Besides direct-access tuning for all standard channels (2 through 139), you can choose channel 0 or 1. These are reserved for two sets of audio-video inputs on MultiVision. I attached my VCR to one set of inputs, a videodisc player to the other. Now I can select either component as easily as a TV channel. "One of those inputs could even be used for a front-door camera," said Pava. "When the doorbell rings, you can see who's there by turning on the inset picture... and not miss the ball game."

Now that's good television.

Made by MultiVision Products (1751 Fox Dr., San Jose, Calif. 95131-2312), MultiVision is $499. PS

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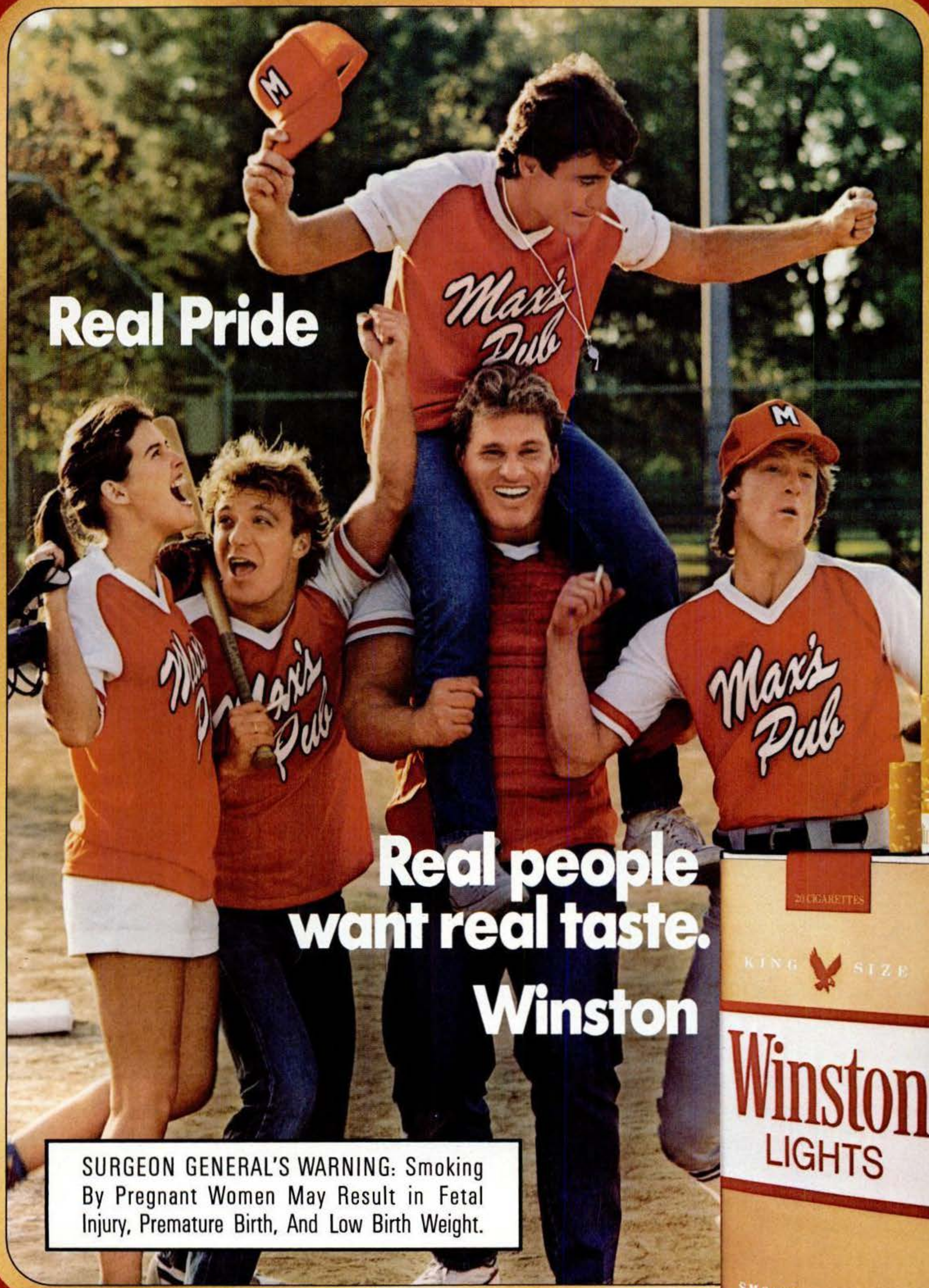

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Flying Porsche

A Cessna 182 (above) is one of several aircraft modified with a 440-lb. Porsche PFM 3200 engine, which burns about 9.5 gal./hr. at cruise speed—compared with the 12.5 gal./hr. of a 230-hp Continental.

By BEN KOCIVAR

HANOVER, WEST GERMANY

I'm standing in Porsche's exhibit at the annual air show here in Germany. Before me, resting on a metal bracket, is a 209-horsepower engine that looks like it might have been lifted from Porsche's 911 sports car—except there's a propeller on one end. And, unlike other airplane engines, Porsche's new PFM 3200 engine burns either 100-octane aviation gasoline or high-test automobile fuel at one-half the price of aviation gas.

This year Porsche is producing an aviation version of its famed six-cylinder air-cooled engine that may stimulate as well as economize popular flying. I spotted the new engine in several airplanes here at Hanover and later at the British Farnborough show.

The power plant is made for general aviation planes in the 200- to 300-horsepower class. A single automatic power control combines the correct power setting, propeller rpm, and fuel-air mixture. That eases a pilot's workload and maximizes fuel economy. Reliability is enhanced by using dual components—twin alternators and vacuum pumps, for example—where failures would be most hazardous.

Instead of relying on rammed-air cooling, dependent on forward speeds, the Porsche has a fan. "The cooling fan provides the proper airflow at all power outputs to extend engine life," says Don Krull, president of Porsche Aviation Products (315 Pine Ridge, Washington, Ill. 61571). PS

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Popular Science

What's News

The energy crisis is over. Performance cars are back; nobody cares about gasoline consumption. OPEC is unable to keep its members in line, so oil prices have dropped. Right?

That's why people are no longer interested in energy conservation... except when they buy a home. *Professional Builder,* a magazine designed for contractors, developers, and other professionals in the building industry, ran a survey with surprising results. Fifty-six percent of new-house buyers, the magazine found, are willing to spend an extra $1,000 on features that save energy. Items almost universally wanted on new homes include storm windows, energy-saving water heaters, zoned heating and cooling, and double-glazed windows.

Rocky V (the furnace) again

A recent piece in POPULAR SCIENCE described a new electric furnace we whimsically dubbed Rocky V [Feb.]. It was developed by the Electric Power Research Institute, and uses cheap off-peak electricity to heat a column containing more than a ton of stones. Then during the day, when electric rates are high, the heat stored in the stones is used to heat the house. Tests of a dozen units last winter demonstrated that the principle worked well during even the coldest spells.

Now the new furnace is going on the market. It will be manufactured by Calidyne Corp. of Elk River, Minn., under the brand name Thermostone III. (I don't know why the company didn't like Rocky V.) According to the company, the furnace will produce electric heat that's competitive in price with gas or oil heat in regions where utilities give lower rates for off-peak use of power. It's estimated the unit will cost about $3,000.

Fans stir controversy

Last month POPULAR SCIENCE ran a piece on how to cut your summer cooling bill using a whole-house fan. The idea is that when conditions are right, you shut off your air conditioner and use a fan to bring in cool night air. Now a study from the Florida Solar Energy Center in Cape Canaveral, Fla., has shown that energy savings have been grossly overestimated.

The problem, say the researchers, is something called MAD—moisture absorption and desorption. That's the process by which water vapor is exchanged between materials inside a house (including the house structure itself) and air in the building. When you turn off the air conditioning at night and bring in cool outside air, you also bring in—at least in Florida—very humid air. The building and its contents absorb moisture during the night. The next day, when the air conditioning is turned back on, this moisture is given up to the now-dryer air and is eventually removed by the air conditioner. This constitutes an additional load for the air-conditioning system that would not have been present had the unit remained on all night and kept the humidity low.

Proponents of whole-house fans claim the fans can save about 26 percent of the air-conditioning bill. The MAD factor, say the researchers, reduces benefits to about one-half that. And savings in an energy-efficient house drop from claimed figures of nearly 40 percent to slightly more than 20 percent with MAD figured in.

El Niño revisited

Last September Robert Gannon reported in PS that two researchers at Lamont-Doherty Geological Observatory were predicting the return of El Niño, a weather disturbance that can cause catastrophic weather changes from Australia to Ecuador and the United States, bring droughts to some places and floods to others, destroy fisheries, and disrupt weather patterns worldwide.

The two researchers, Mark Cane and Stephen Zebiak, had come up with a new model—a theoretical framework—explaining how factors ranging from prevailing winds to ocean surface temperatures changed from time to time to produce an El Niño event. Cane and Zebiak predicted that a new El Niño would begin developing sometime in 1986 and arrive during the winter of 1986–'87. Meteorologists around the world waited. Nothing happened. Many wrote off the prediction and the work that went into it.

Now, signs have begun to appear. On Jan. 12 the National Oceanic and Atmospheric Administration issued an advisory stating that rainfall had been heavy in the central Pacific since November. An approaching El Niño would raise surface water temperatures in that area and produce such a result. The Philippines, Indonesia, and northern Australia have been drier than normal. And in the U.S., Gulf Coast states have been wetter than normal and western states warmer than normal—again, consistent with an approaching El Niño.

Compared with the 1982–'83 El Niño—which killed 1,100 people, wiped out sea life over a vast range, and caused $8 billion in damage—the present changes are mild. Sea surface temperatures in the central Pacific—a sensitive indicator—are two to four degrees above normal, compared with seven or, in some cases, even 10 degrees above normal four years ago.

Nevertheless, the trend seems significant. And if it continues, by the time you read this Peru and Ecuador may be undergoing floods; fisheries off their coasts could be producing below-average catches; and weather disruptions could be appearing that would have dire effects around the world.

And there's one other clue: The National Geographic Society in Washington, D.C., reports that iguanas, finches, and green sea turtles in the Galápagos Islands began breeding in September last year—several months earlier than usual. These animals, say experts, are highly sensitive to temperature changes. And the changes that would trigger early breeding are those that would be expected to precede an El Niño.

C. R. Gilmore

Editor-in-Chief

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MINICAR

Multinational minis from Korea, Yugoslavia, Japan, and Brazil (clockwise from the upper left): Hyundai Excel, Yugo GV, Subaru Justy, Pontiac LeMans, VW Fox, and Ford Festiva.

New cars from around the globe are invading the small-car market. Here's how the new low-cost imports from Eastern Europe, Latin America, and East Asia stack up.

By JACK KEEBLER, DAN McCOSH, and TOM WILKINSON

One comes from Yugoslavia. Another is built in Brazil. The third hails from Japan. Three more are from Korea.

Though their origins are very different, the Yugo GV, Volkswagen Fox, Subaru Justy, Hyundai Excel, Ford Festiva, and Pontiac LeMans have much in common. Except for the Japanese Justy, all are from developing nations that have never sold cars here before. All but the LeMans have base prices under $6,000, and even the LeMans is expected to squeak in at under $7,000.

There have always been buyers for cheap sensible transportation. It's just that there haven't always been good cheap cars. The VW Beetle is but a rusty memory. American manufacturers have all but abandoned the low-price market. Even the Japanese economy car is an endangered species, its prices battered by changing currency rates, then bloated with options and added dealer profit.

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INVASION

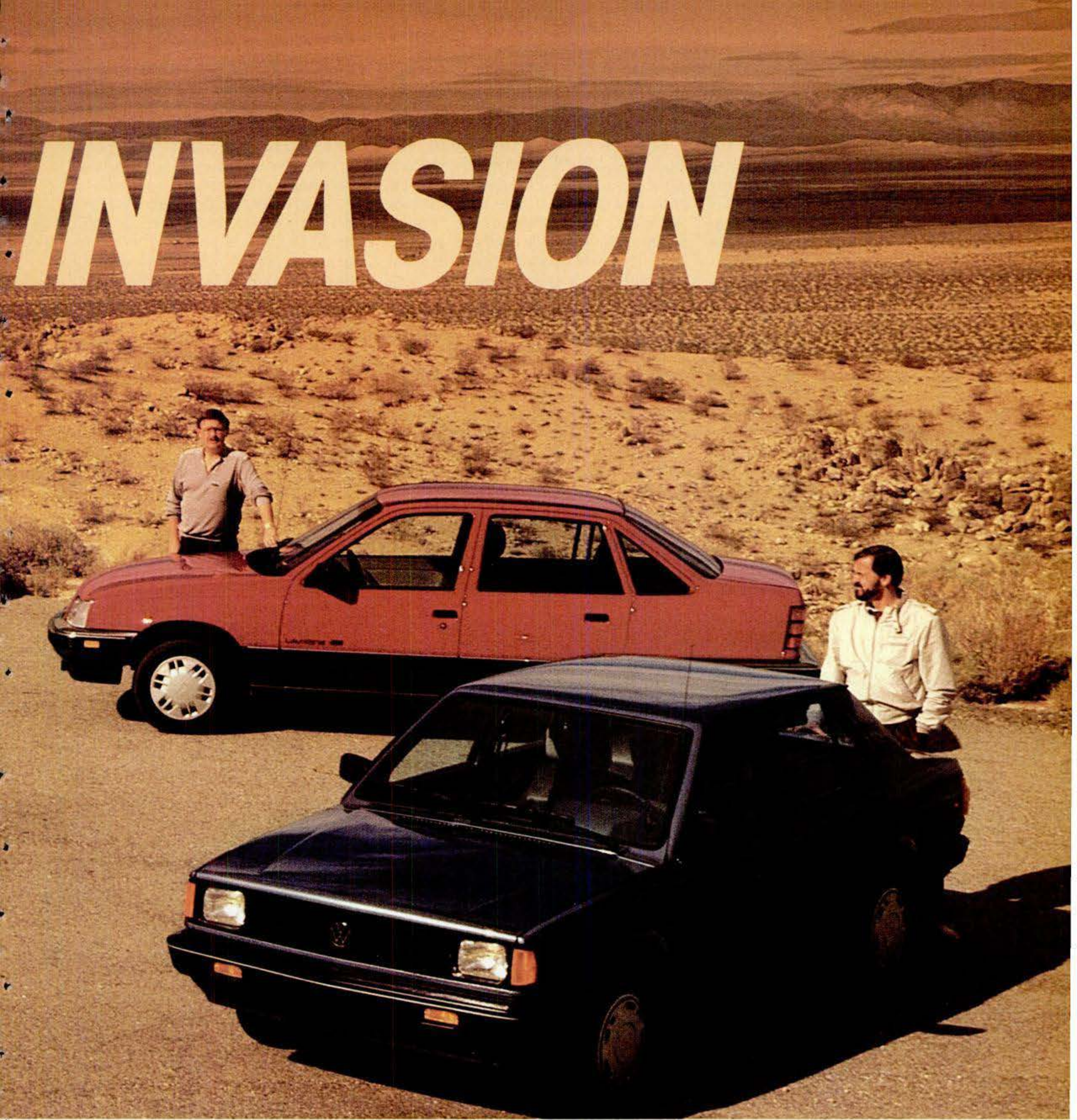

PHOTO BY GREG SHARKO

Two trends have converged to make this latest batch of small cars possible. First, these are among the smallest cars sold in the United States. Such mini-compacts are popular in Europe and Japan, where fuel costs and taxes are high. But now car makers are betting that low sticker prices can attract even Americans to these tiny sedans. Also, industrial growth in Eastern Europe, Southeast Asia, and Latin America has created factories where cars designed in Japan or Western Europe can be built at low cost. The result of these two trends appears on this issue's cover—a broad range of minicars, some with familiar names, built up from recognizable bits and pieces.

Together, these multinational minis offer American buyers more small-car choices than ever before. Indeed, because they're designed and built in so many different places, the cars in this group are probably less alike than any group of cars we've tested recently. To help you sort through this wealth of new models, we look first at the engineering that makes such low prices possible, then analyze our instrumented testing of the six, and finally look at how these newest minicars compare in day-to-day driving.

Unusual engineering

"A nine-valve engine? What's a nine-valve engine?" asked one auto engineer, bemused by the oddball specifications for the Subaru Justy. The three-cylinder engine, with its two intake valves and one exhaust valve per

Continued

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cylinder, was just one of the unusual features found in our group of tiny, low-priced sedans.

The engineering problems of putting together low-cost cars are often just as tough as those involved in building a Ferrari because problems can't be solved by throwing money at them. The car must carry four passengers in a diminutive package, get 30 miles per gallon or better, and sell at a profit for $6,000 or so. To save on expensive tooling, existing engines, transmissions, and chassis parts must be blended with new body panels. Passengers and luggage can make up 30 percent of total vehicle weight, putting a great burden on small engines and simple suspension systems.

The most basic car of the group, the Yugoslavian-built Yugo GV, derives much of its engineering from older Fiat models. Its 1.1-liter overhead-camshaft four is fitted with a simple two-barrel Carter-Weber carburetor, and a four-speed manual is the only transmission offered.

Like all cars in the group, the Yugo uses MacPherson struts and coil springs up front. Steering is manual rack and pinion. Struts and a transverse leaf spring provide suspension at the rear. Stiff springs are used to beef up load-carrying capability, and combined with the Yugo's short (84-inch) wheelbase, they made for a choppy ride even on smooth freeways.

Next up the price ladder is the Hyundai Excel, which is based on Mitsubishi components and assembled in Korea. Indeed, Mitsubishi now imports its own version of the Excel, called the Precis, for sale in the U.S. The Excel is larger and heavier than the Yugo, and the additional mass makes it feel more substantial. The Excel also has the most sophisticated rear suspension in the group, with independent trailing arms, progressive-rate coil springs, and a stabilizer bar.

The Subaru Justy, the only car in the group built in Japan, relies on its small size and unusual design to offset Japan's higher labor costs. Its three-cylinder engine is relatively powerful, thanks to its three-valve cylinder head, but it also growls with a peculiar note, thanks to its odd number of cylinders. A counterrotating balance shaft and silicone-filled motor mount help keep engine shake from reaching the driver, but the sound still takes some getting used to.

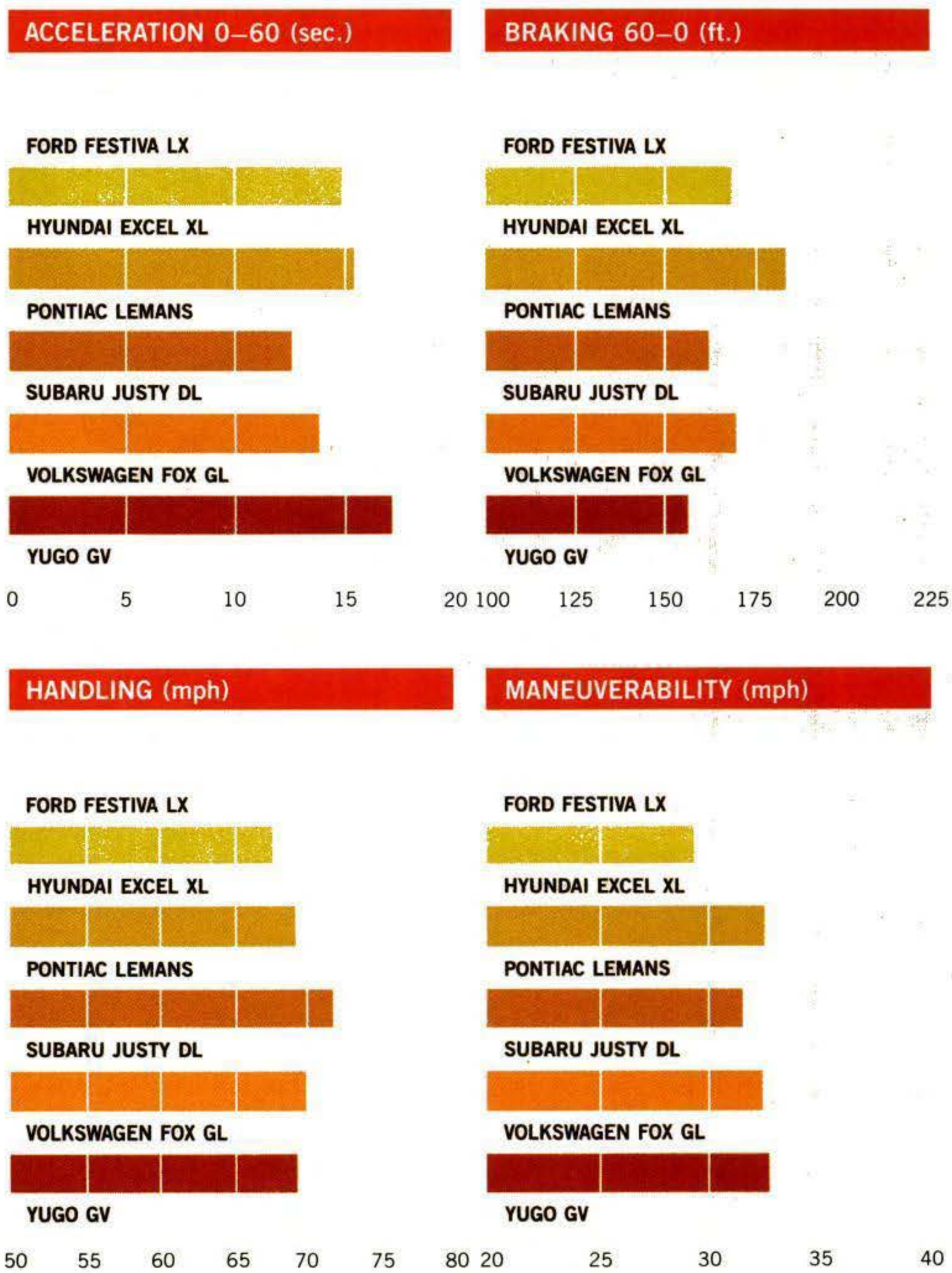
Otherwise, the Justy is a traditional Japanese mini. The body, transmission, suspension, steering, and brakes are all familiar; they're just smaller than you're used to.

On paper, at least, the Korean-built Festiva looks like the most ordinary car in the group. Designed by Ford of Japan, the Festiva relies on a Mazda-built 1.3-liter four with a cast-iron block and two-valve aluminum head. Power output is a modest 58 horsepower, but then the Festiva weighs but 1,713 pounds. Like the engine, the Festiva's suspension is basic, with MacPherson struts up front and a twisting-beam axle in the rear.

The Fox is built by Autolatina, a company formed by the recent merger of VW and Ford operations in Brazil and Argentina. The Fox has the largest engine of the six cars, a 1.8-liter four that's nearly identical to that used in the Golf and Jetta. At 81 horsepower, it's the most powerful engine in the group. But then with its 2,200-pound curb weight, the Fox four-door was outweighed only by the LeMans.

Unlike those in the other cars tested, the Fox engine was mounted fore-and-aft, driving the front wheels through a four-speed transaxle. The chassis of the Fox is conventional VW, though, with MacPherson strut suspension in front and a twisting-beam axle in the rear.

The last car in the group, the LeMans, is based on the Opel Kadett introduced in Europe in late 1984, and is built by Daewoo in Korea. Probably the most expensive car in the group (Pontiac hadn't announced the base price by press time, but it was rumored to be near $7,000), the LeMans is closely related to larger front-drive General Motors cars. The transverse 1.6-liter four is similar to the two-liter engine used in U.S.-built Pontiacs. It even shares the Rochester throttle-body injection found on millions of GM cars. And our test car was equipped with the THM 125-C three-speed automatic used throughout GM's line.



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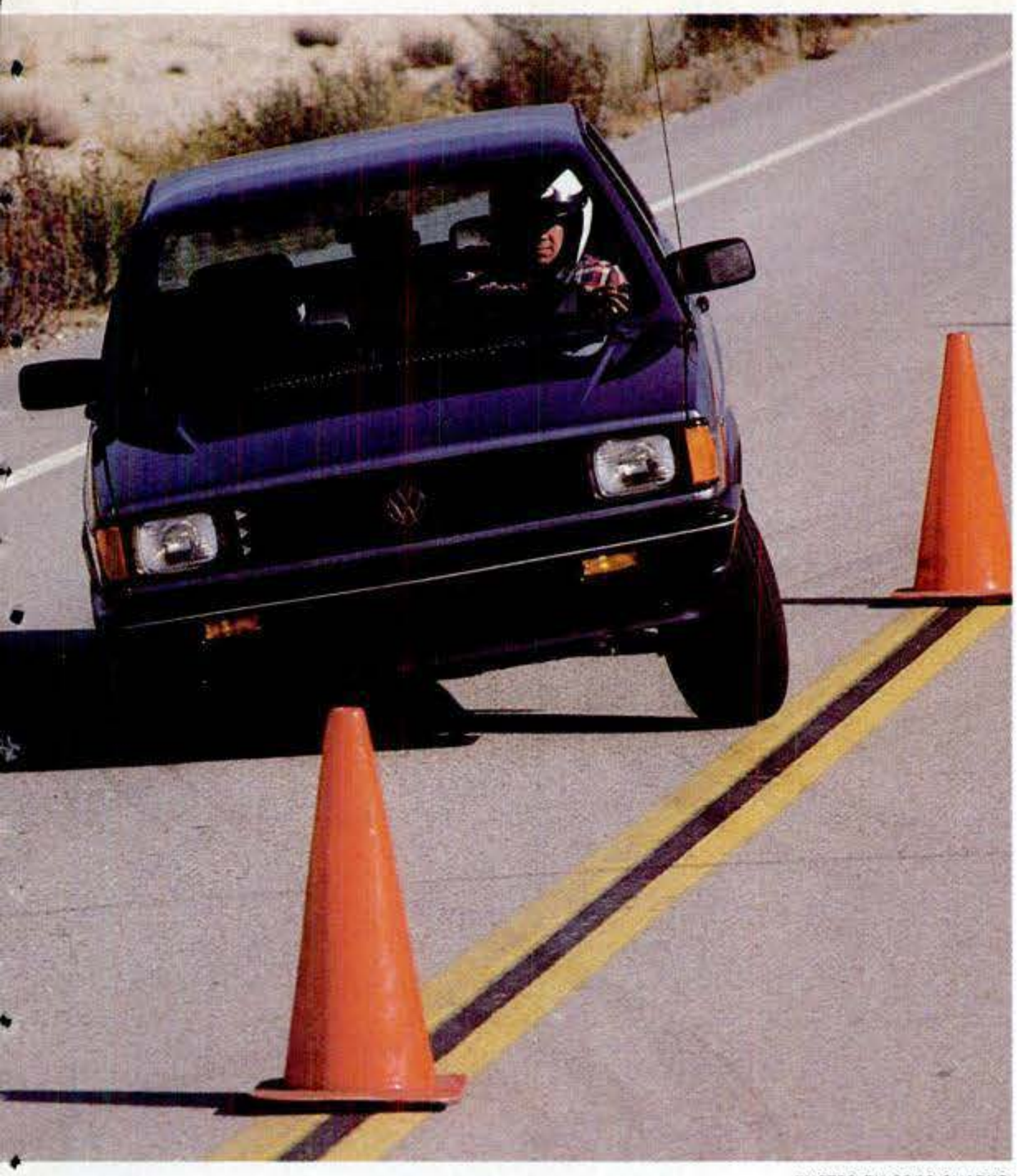

Though the body rolls noticeably during this low-speed slalom, the VW Fox (left) was quick and predictable. The Pontiac LeMans (above) scoots through just a hair faster than the Fox, thanks in part to its optional power steering.

PHOTOS BY GREG SHARKO

Still, when it comes to engineering details, it's wise to remember that they're a bit like insults—it's not what you say, but how you say it that counts. As our instrumented and driving tests revealed, well-executed simplicity seemed to mean more in these cars than sophisticated technology.

Small performers

Given that only one car, the Hyundai Excel, had ever been tested by POPULAR SCIENCE, we could hardly wait to strap our fifth wheel onto these minicars. Braving mid-February weather at our test strip at Stewart Airport in upstate New York, we set out to find out how well the six would perform. Overall, we were pleasantly surprised.

The Yugo has endured its share of insults, but it emerged as the braking champ of the group, with three of its five stops at under 160 feet. Though not the absolute best in either handling test, the Yugo's performance was respectable. Despite its tall, tippy appearance, it felt stable, and went exactly where it was steered. Only in acceleration and noise did it suffer: Even the LeMans, with a three-speed automatic, beat it to 60 mph. And engine, wind, and road noise conspired to make the Yugo the noisiest car of the six.

The first time we tested a Hyundai Excel [PS, July '86], we recorded stopping distances of 200 feet plus and considerable brake fade. Though there was still some fade this time, the stops were much shorter, averaging 167 feet. In the acceleration runs, the Excel was about mid-field, averaging 15 seconds from 0 to 60. Noise level, too, was about average for the group. The optional five-speed would have quieted the engine buzz at 60 mph.

Though it had the most complex rear suspension, the Hyundai placed last in both the high-speed and low-speed grids. Body roll was plentiful, and the car didn't feel particularly precise during hard corners. But even though it finished last, the Hyundai's times were still above the average of cars PS has tested over the last four years—an indication of just how well the narrow, lightweight cars in this group handle.

The Justy may be tiny, but it's no lightweight when it comes to performance. It had the second-best brakes in the group, with stops averaging 163 feet, and good pedal feel made it easy to get short, sure stops. And when you move your right foot to the throttle pedal, the Justy goes: The three-cylinder engine blasted the car from 0 to 60 mph in 12.8 seconds, making it the fastest of the group. Also, its light weight and narrow track helped make the Justy the champ in the high-speed handling test. On the negative side, road noise is high, and even the balance shaft and silicone-filled engine mount couldn't quiet the raucous little three.

The next car in the group, the Ford Festiva, proved to be the maneuverability champ, thanks in part to its nimble feel and light steering. The tall seats and great all-around vision also helped, making it easy to place the car exactly where you wanted it.

Zero-to-60 times were good for a 1.3-liter car. The engine was far smoother than that in the Justy, and putting the Festiva's optional five-speed transmission through its paces was a joy. The throws were short, and it took but a nudge of a finger tip to move it from gear to gear. Braking distances, on the other hand, were only average at 172 feet.

The Fox stopped just a hair shorter than the Festiva, and the brakes had a confidence-building directness of action. Not only was the big four-cylinder engine in the VW smooth and quiet, it was also powerful. The VW was quickest to 30 mph, and was barely edged out by the lighter Justy to the 60-mph mark.

As a drag racer, the Fox is handicapped by the widely spaced ratios in its four-speed transaxle (the only transmission currently available). This didn't prove to be a problem in normal driving. Even though you can't always keep the engine operat-

Text continued on page 104

Turn page for specs and test results

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POPULAR SCIENCE TEST RESULTS

TEST RESULTS	Ford Festiva LX	Hyundai Excel XL	Pontiac LeMans	Subaru Justy DL	Volkswagen Fox GL	Yugo GV
Acceleration (sec.)						
0–30 mph	4.1	4.2	4.5	3.7	3.6	4.8
0–60 mph	14.1	15.0	15.6	12.8	13.9	17.3
Brake test 60–0 mph						
Stopping distance (ft.)	172	167	184	163	170	157
Pedal pressure, cold (lbs.) (0.5-G stop)	15	15	10	11	10	10
Pedal pressure, hot (lbs.) (0.5-G stop)	20	35	15	10	15	20
Handling test (mph)	69.8	67.9	69.4	72.0	70.2	69.6
Maneuverability test (mph)	33.6	29.4	32.7	31.7	32.6	32.8
Interior noise (dBA)						
At idle	42	47	51	51	52	50
At 60 mph	70	70	70	74	68	75
EPA FUEL MILEAGE (mpg)						
Highway	43	31	32	41	30	32
City	39	28	26	38	26	29

Dimensions and specs

DIMENSIONS (inches)						
Wheelbase	90.2	93.7	99.2	90.0	92.8	84.6
Overall length	140.5	161.0	163.7	139.2	163.4	139.0
Overall width	63.2	63.1	65.5	60.4	63.0	60.7
Overall height	55.3	54.1	54.7	54.7	53.7	54.7
SPECIFICATIONS (as tested)						
Engine type	In-line 4	In-line 4	In-line 4	In-line 3	In-line 4	In-line 4
Displacement (cu. in./liters)	81/1.3	90/1.5	98/1.6	73/1.2	109/1.8	68/1.1
Compression ratio	9.0:1	9.5:1	n.a.	9.1:1	9.0:1	9.2:1
Induction	2-bbl. carburetor	2-bbl. carburetor	EFI	2-bbl. carburetor	FI	2-bbl. carburetor
Net horsepower @ rpm	58 @ 5,000	68 @ 5,500	74 @ 5,200	66 @ 5,200	81 @ 5,500	54 @ 5,000
Net torque (lb.-ft.) @ rpm	73 @ 3,500	82 @ 3,500	88 @ 3,400	70 @ 3,600	93 @ 3,250	52 @ 4,600
Transmission	5-speed manual	4-speed manual	3-speed automatic	5-speed manual	4-speed manual	4-speed manual
Final drive ratio	3.78:1	3.47:1	3.74:1	4.44:1	3.89:1	3.76:1
Steering	Rack and pinion	Rack and pinion	Power, rack and pinion	Rack and pinion	Rack and pinion	Rack and pinion
Turn diameter (ft.)	n.a.	33.8	32.2	29.6	31.5	31.2
Front suspension	MacPherson strut with coil springs	MacPherson strut with coil springs	MacPherson strut with coil springs	MacPherson strut with coil springs	MacPherson strut with coil springs	MacPherson strut with coil springs
Rear suspension	Torsion beam with coil springs	Trailing arm with coil spring	Torsion beam with coil springs	MacPherson strut with coil spring	Torsion beam with coil springs	Struts with leaf spring
Brakes	Disc-drum	Disc-drum	Disc-drum	Disc-drum	Disc-drum	Disc-drum
Curb weight (lbs.)	1,713	2,156	2,223	1,655	2,190	1,832
F/R weight distribution (%)	n.a.	63/37	n.a.	63/37	n.a.	64/36
Fuel tank (gal.)	10.0	10.6	13.0	9.2	12.4	8.4
Trunk volume (cu. ft.)	11.7	7.8	13.5	8.8	9.9	9.0
Base price	$5,765	$5,195	$6,900*	$5,495	$6,490**	$3,990
Price as tested (less freight)	$7,200[1]	$5,665[2]	$8,700[3]*	$6,385[4]	$7,475[5]	$5,208[6]

Major options (over $100): [1](estimated costs) A/C $700, LX package $500, AM-FM cassette $200; [2]AM-FM cassette $295, XL package $175; [3](estimated costs) A/C $650, AM-FM cassette $500, automatic transmission $400; [4]A/C $650, AM-FM radio $200; [5]A/C $650, radio prep $185; [6]premium comfort and sound package (A/C and AM-FM cassette) $999, rear washer-wiper $129

* Estimated

** Two-door Fox base price: $5,690

Parts and service

PART PRICES (manufacturers' suggested retail)						
Brake pads, front	n.a.*	$ 26	n.a.*	$ 45	$ 80	$ 15
Brake pads/linings, rear	n.a.	33	n.a.	30	50	24
Front shock/strut insert	n.a.	68	n.a.	135	50	59
Alternator	n.a.	281	n.a.	351	156	174
Fuel pump	n.a.	42	n.a.	65	164	22
Ignition module	n.a.	200	n.a.	—	113	120
Grille	n.a.	38	n.a.	108	38	55
Front bumper	n.a.	103	n.a.	91	72	99
Windshield	n.a.	165	n.a.	287	189	179
Taillight lens	n.a.	33	n.a.	74	47	7

* New model, prices not available

PS serviceability ratings

Checking oil level	5	4	5	4	5	5
Checking coolant level	5	5	5	5	5	5
Adding oil	5	5	5	5	5	5
Changing oil filter	2	3	4	2	4	4
Changing spark plugs	5	4	5	4	5	4
Changing belts	3	3	3	3	4	2
Changing radiator hoses	4	3	4	3	3	4
Changing heater hoses	3	2	3	3	3	3
Checking fuses	5	4	4	5	4	3
Spare-tire access	3	3	2	3	4	4

(Ease of service: 5 = excellent, 1 = poor)

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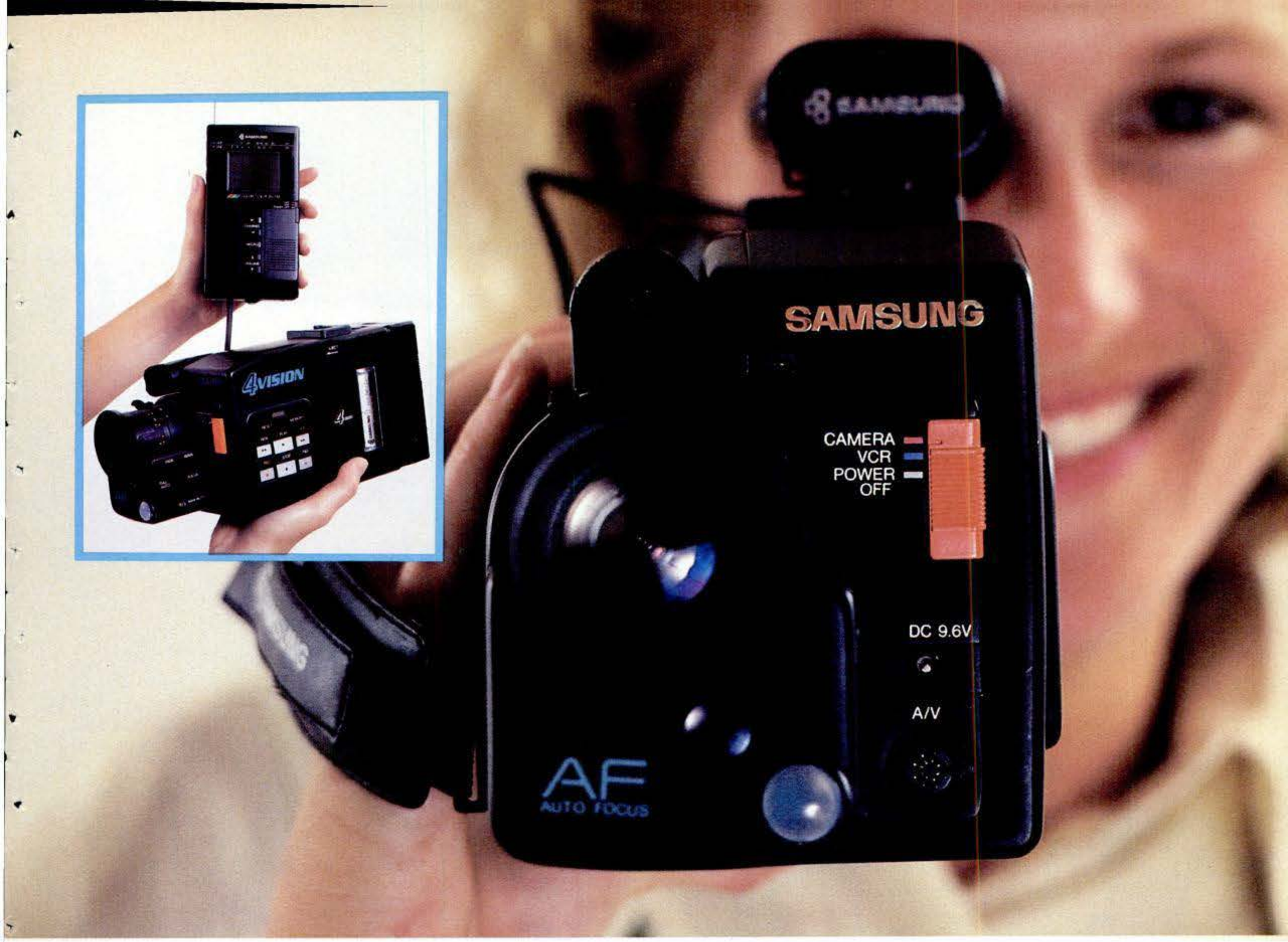

Samsung's camcorder has an f/1.6 lens with 6:1 zoom and autofocus. With TV tuner (inset), it becomes a VCR.

Palm-sized camcorder —smallest unit yet is a complete VCR, too

VHS-C and 8-mm makers have a new rival: Samsung's 2.4-pound camcorder-VCR records for 60 minutes on a 4-mm DAT cassette.

By WILLIAM J. HAWKINS
Photo by Greg Sharko

"Bet you never saw one like this before," says Donald Kobes, national communications manager for Samsung Electronics America. His voice is soft and calm —unusual for the bustling Consumer Electronics Show in Las Vegas. He lifts a tiny box from the table. "It's the lightest camcorder made," he says. "And it's also a VCR." Kobes flips the camera-recorder on its side, presses a button, and ejects its tape—a 4-mm digital-audio-tape (DAT) cassette.

A camcorder that doubles as a VCR and uses DAT instead of VHS or 8-mm cassettes? Different? Yes... and risky.

The 8.4-by-5.3-by-4-inch 2.4-pound (without battery) unit I now hold is a non-working prototype. It has two rotary helical-scan heads to record up to 60 minutes on a cassette. When used as a camcorder, the video source is the unit's ½-inch seven-lux charge-coupled-device imager. "The picture quality will be slightly lower than eight-millimeter," says Kobes, "and about the same as VHS."

The video information is stored on the tape in a format much like that of VHS. The video signal is recorded across the tape, and analog audio is recorded along the tape's edge. "By changing the tape speed," says Kobes, "future camcorders could record for more than an hour." (As with VHS, slowing the tape to gain recording time means a loss in picture quality, however.)

The unit has all the standard features: fade, white balance, autofocus, power zoom, and a 0.6-inch monochrome electronic viewfinder. A liquid-crystal-display (LCD) tape counter is on the side, along with tape-control buttons for rewind, fast forward, pause, record, and play. (Some camcorders are record-only models.)

[Continued on page 100]

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Solving unsolvable puzzles with SUPERCOMPUTERS

A calculation that takes one second on a modern supercomputer would have taken a year on the most powerful computer at the end of the 1940s. With this enormous speed, scientists are able to solve problems that would have taken decades not too long ago.

By ARTHUR FISHER

What exactly is a supercomputer? Simply the best (read "most powerful") calculating device available at a given moment. Once, that must have been some quick-thinking individual's fingers and toes. A few blinks of an eye later in human history, those 20 digits would have been superseded by an abacus, and then by Pascal's adding machine of 1642 and Babbage's Difference Engine of 1822.

In 1943 the first large-scale automatic digital computer was built. It was Harvard's Mark I, designed by Howard Hathaway Aiken, and was also known as the IBM Automatic Sequence Controlled Calculator. It was a gargantuan device, 51 feet long and eight feet high, weighing five tons. It took 500 miles of wire to interconnect its 750,000 components, many of which were electromechanical, including more than 3,000 relays. It could multiply 23-digit numbers in three seconds, and was used to solve problems in ballistics and nuclear-bomb design.

Today's modern supercomputers possess a power—depending on how you measure that sometimes slippery quantity—some 10 million times greater than that of the heroic pioneers of the 1940s. One commonly accepted measure of computer power is speed, measured in flops—short for floating point operations (calculations) per second. At peak performance (this depends to some extent on the kind of problem being attacked), the Cray-1 is rated at about 100 megaflops. (Mega equals a million.) The Cray X-MP and the Cyber-205 come in at about 400 megaflops.

This evolution has turned many computational nightmares into exercises that are at least feasible in terms of time and money. Take the problem of modeling airflow over an airplane's wing. In the days of the wild blue yonder, a plane's designer did this mostly by guess, trying out various shapes with models in wind tunnels, and then sending test pilots aloft on a wing and a prayer. ("A wind tunnel is an insult," the eminent mathematician and computer genius John von Neumann once remarked.) Computer simulation is obviously a much more appealing approach. And today that task can be performed in a half-hour at a cost of $1,000 in computer time.

In 1960 the same job would have cost $10 million, and it would not have been finished until 1990.

Yet this enormous, exponential increase in computing power falls short of current and future needs. For example, physicists and engineers at NASA and at various national laboratories of the Department of Energy yearn for computing power of at least 10 gigaflops—10 billion flops.

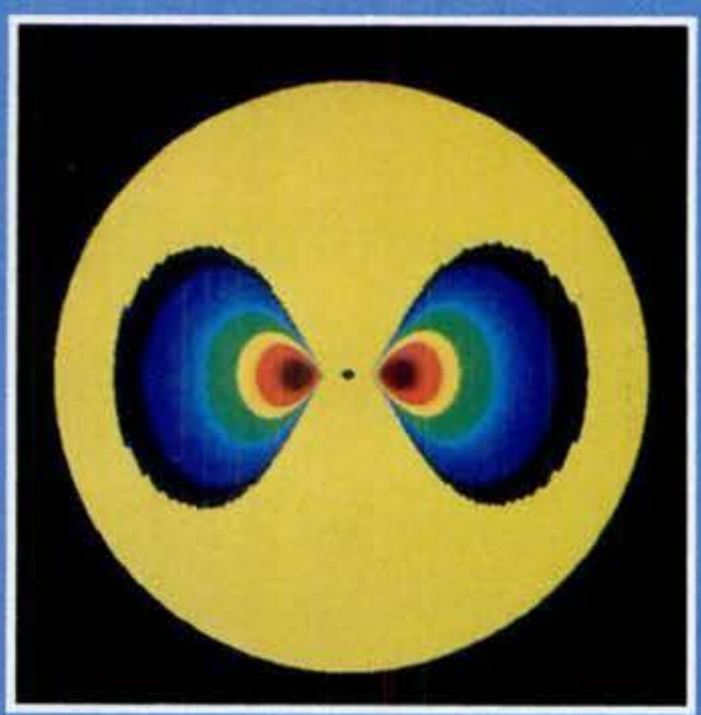
Why so much? The answer lies in the mathematics of the kinds of problems scientists in every discipline, from astrophysics to aerodynamics, are trying to solve. The phenomena they deal with can be represented mathematically by nonlinear partial differential equations. And exact solutions to such equations are essentially impossible. Solutions can only be approximated by elaborate calculations, and as the complexity of the problem grows, so grows—exponentially—the amount of calculation and the computing power needed to cope with it.

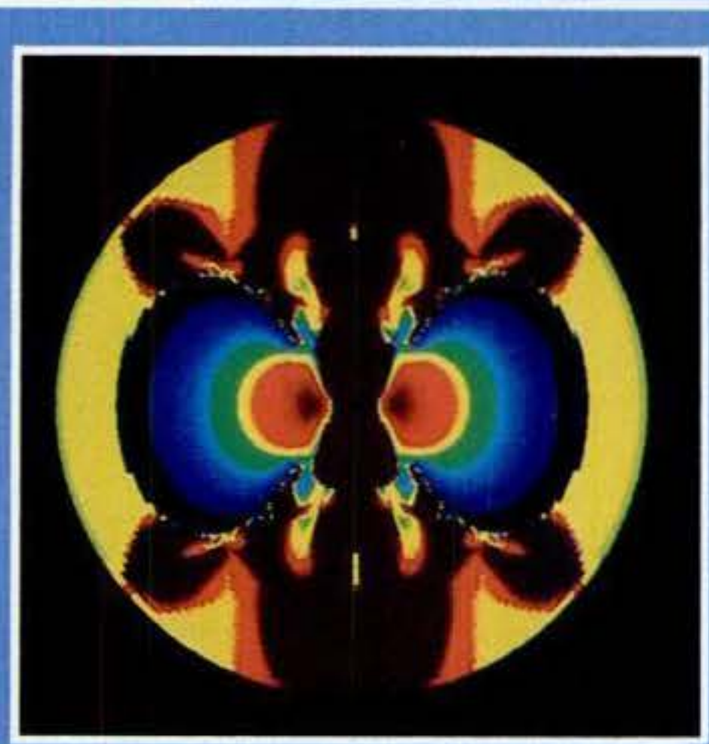
Linear behavior is one in which a given input produces a directly proportionate output: Push twice as hard on an object, and you accelerate it twice as much. But very few phenomena in the real world are linear. In fact, it is peculiar to call everything else nonlinear. As the late mathematician Stanislaw Ulam once said, "This is like referring to the class of animals that are not elephants as non-elephants."

One prime example of nonlinear behavior is turbulence, which is everywhere in the universe, from gurgling water in a pipe to Jupiter's great red spot—and the tumble of air over a plane's wing. Turbulent flow is unpredictable. Alexandre Chorin, a mathematician at the University of California, Berkeley, likes to tease his physicist friends by challenging them to predict how much water will spurt from a garden hose in a given time. "They simply can't do it," he says. Supercomputers can at least provide good, though not exact, answers to many of these problems—provided they are powerful enough so that the expenditure of time and money is not inordinate. It has been a long-standing joke among meteorologists, for example, that their models are good enough so that they could prepare a highly accurate forecast of the following week's weather, only it would take three months on the computer.

The gallery of computer graphics on the following pages are examples of supercomputer successes, in which once unsolvable problems have been resolved. They represent a stunning vindication of von Neumann's prediction, made in 1946: "Really efficient high-speed computing devices may . . . in many fields which are now difficult or entirely denied of access, provide us with those heuristic hints which are needed in all parts of mathematics for genuine progress." PS

ASTROPHYSICS





BLACK HOLES result from the collapse of an exploding star, a supernova, into a superdense pinpoint with an enormous gravitational field. In some galactic models, strong emissions of energy from the galactic center result from the inflow of gas into the black hole. In this computer sequence, done on a West German Cray-1 by Larry Smarr and John Hawley, the central dot is the black hole, and the droplike shapes at either side are a cross section of a ring of gas around the hole, with the red portions being the hottest and the black portions the coolest. As the simulation progresses, the gas is pulled into the hole, and some of it splashes back out.

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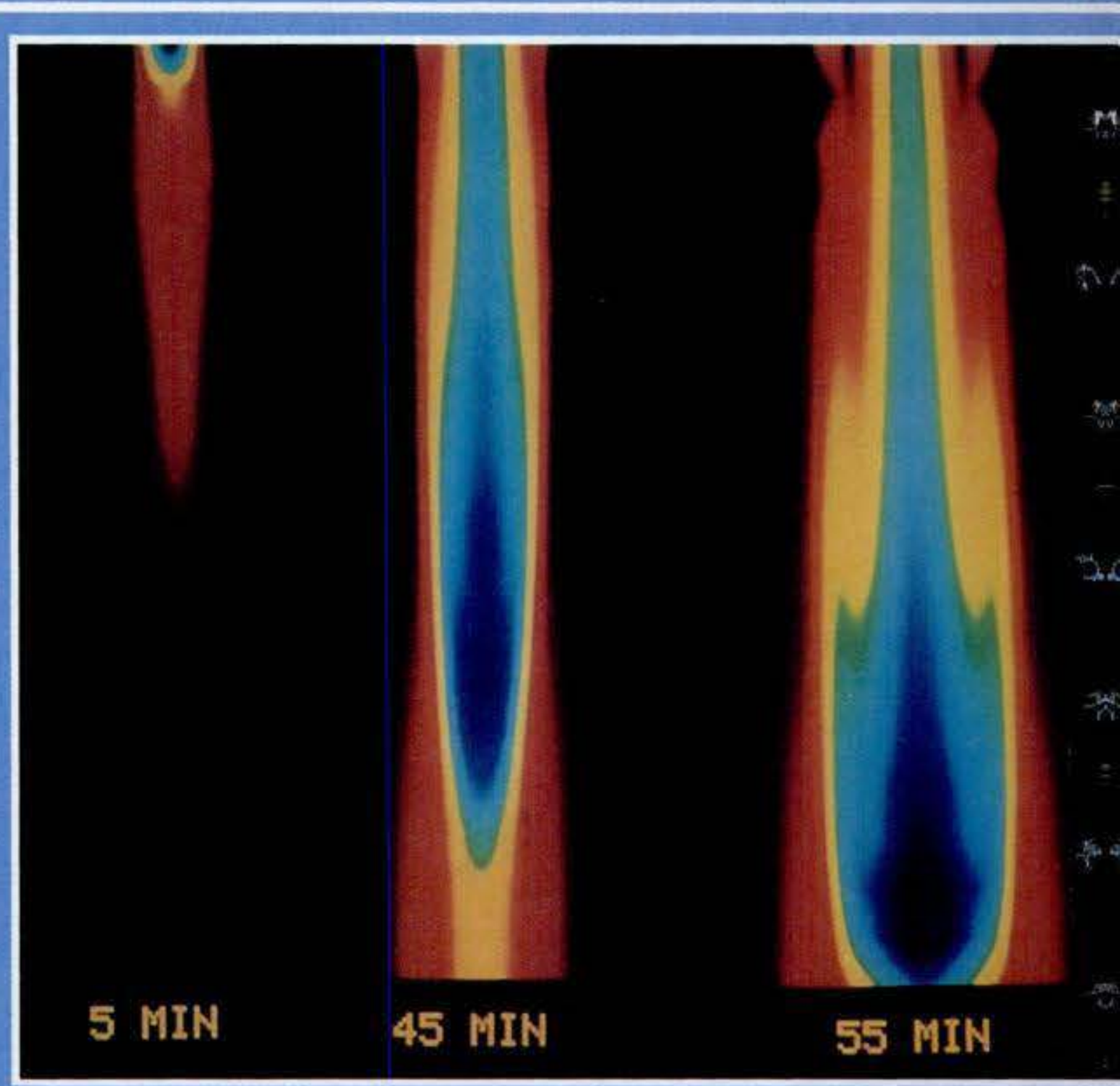
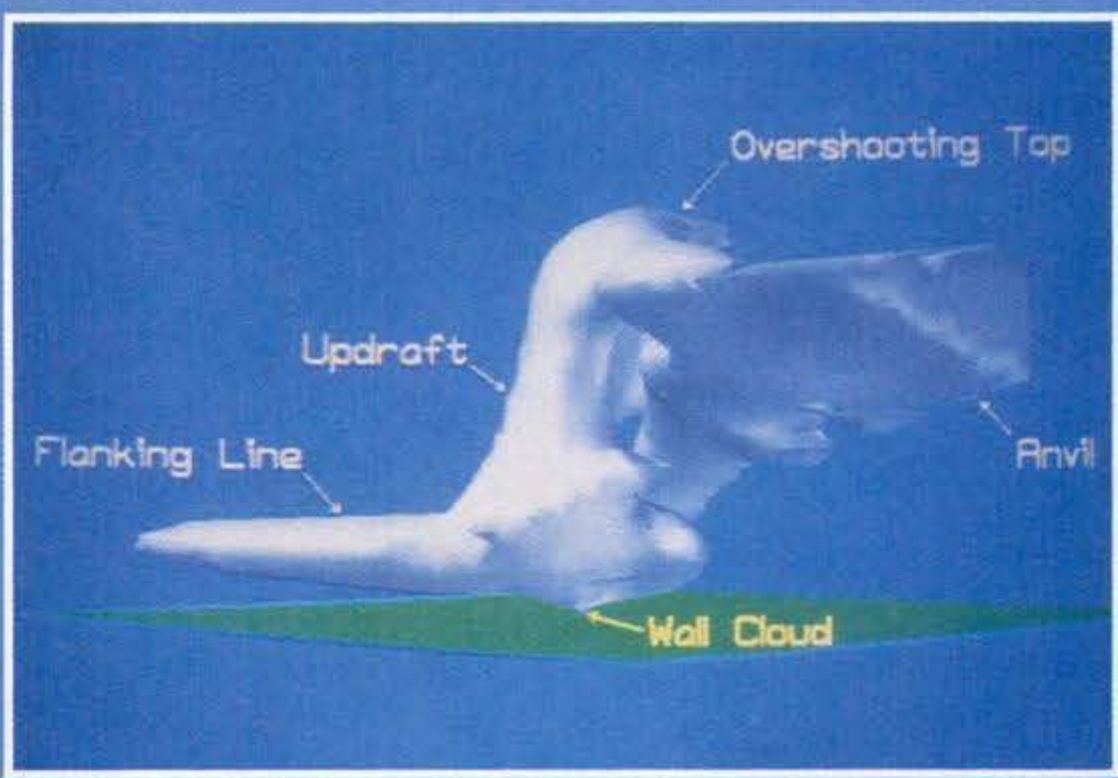
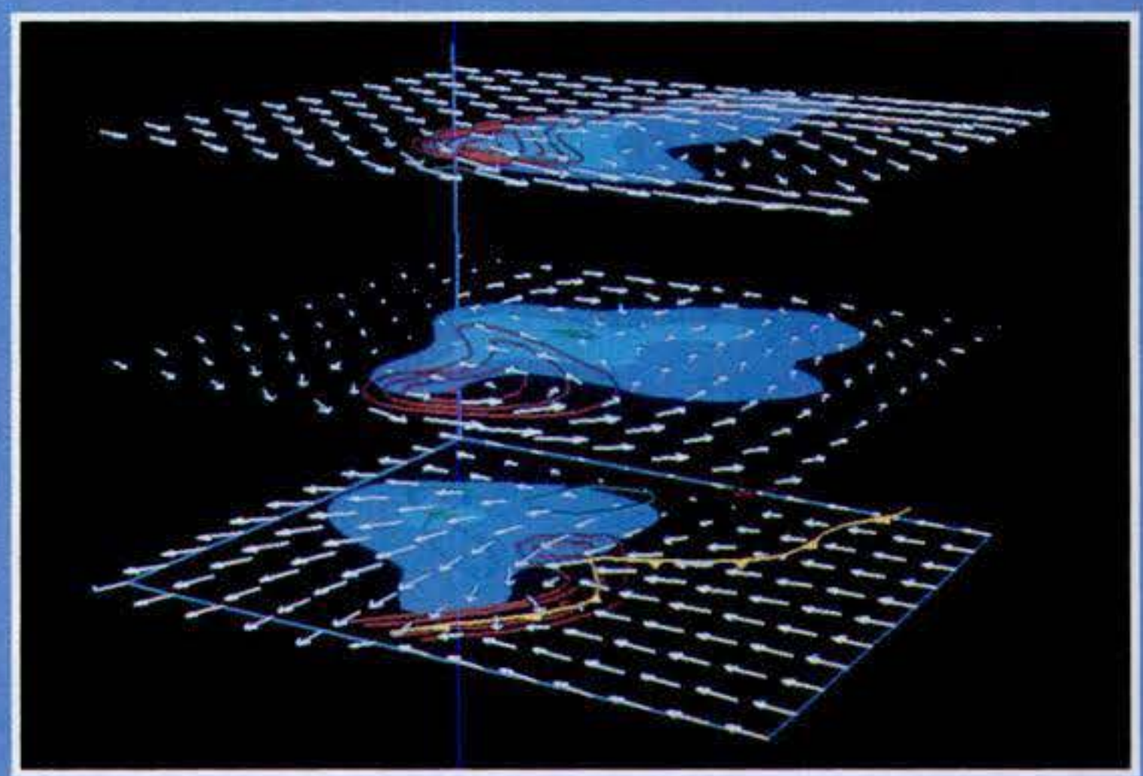
METEOROLOGY



WIND SHEAR is now recognized as a meteorological phenomenon that presents serious hazards to aircraft, especially during takeoffs and landing approaches ["Wind Shear," PS, March]. It has been indicted as the cause of a number of fatal accidents, and is probably involved in many more. Wind shear is simply a sudden change in wind speed and direction over a short distance. A common type of wind shear, and the one most frequently involved in hazardous flying conditions, is the microburst—a strong downdraft, associated with a thunderstorm or cloud, that abruptly descends and spreads out horizontally in a whirling mass of turbulent air. Weather experts once thought that microbursts accompanied only significant thunderstorms, but recent observations show they can descend without warning even from small, innocent-appearing rain clouds.

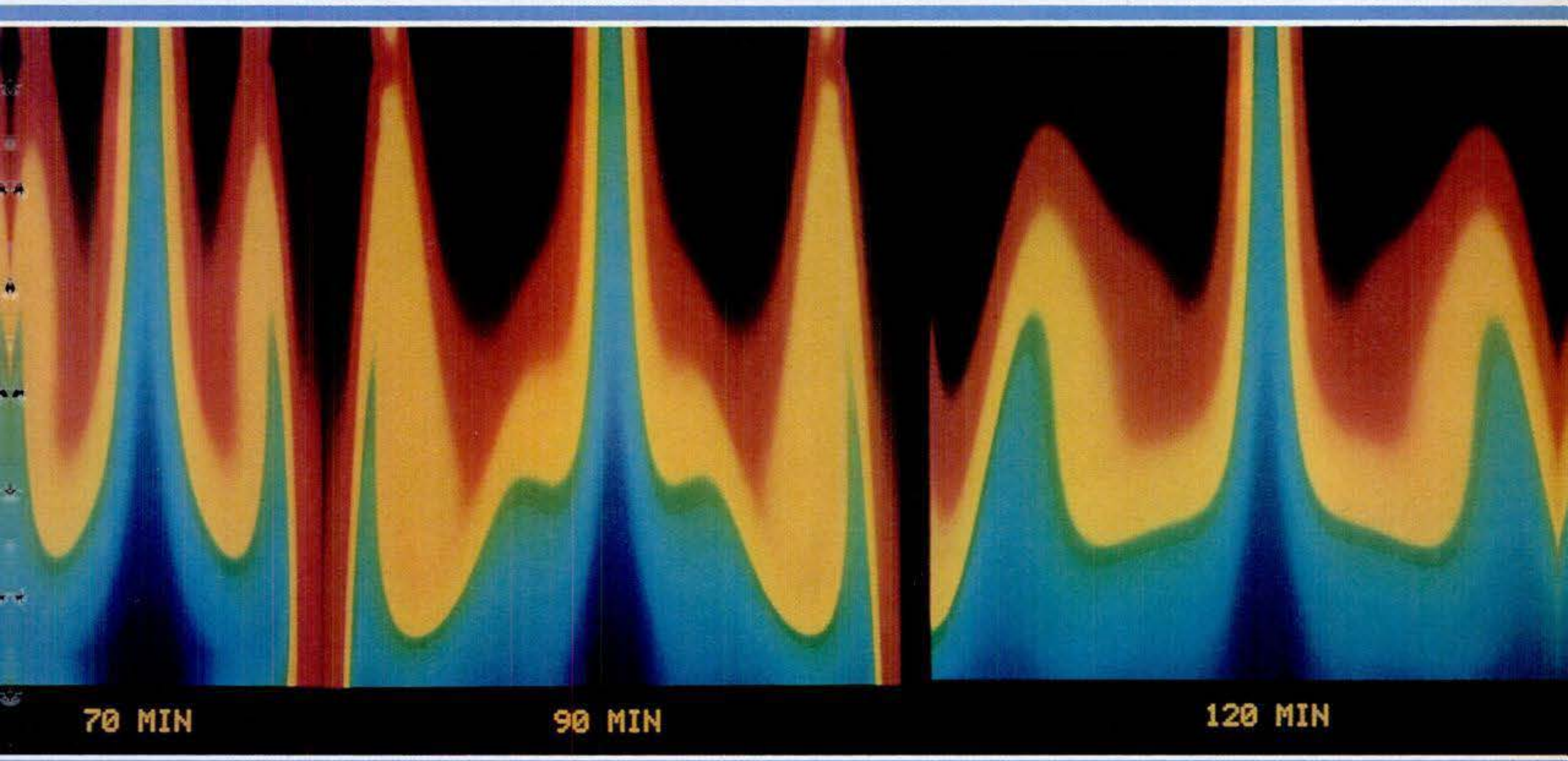
One approach to avoiding microbursts and other wind-shear dangers is to develop new radar systems for installation either aboard aircraft or at airports, or both, that can best detect microbursts. To do this, meteorologists and engineers must know more about microbursts' physical





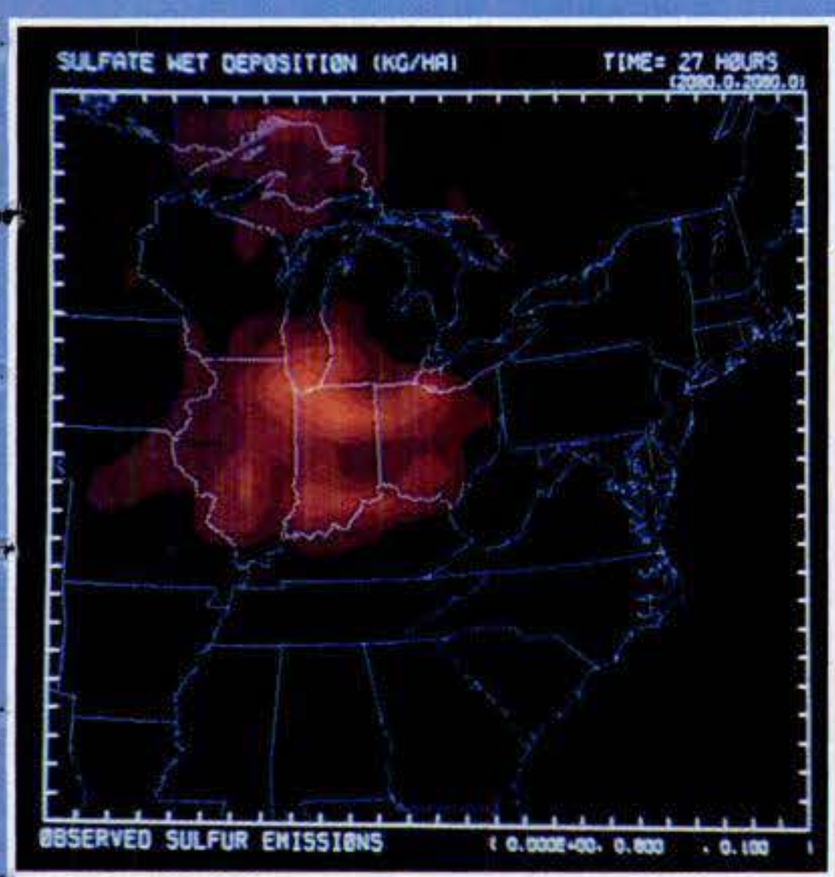
TORNADO PREDICTION that is timely—a lifesaving goal—is the subject of the two Cray-1 computer simulations shown here. They form part of the research of two scientists at NCAR, Joseph Klemp and Richard Rotunno. The ability of a supercomputer to display and evaluate data "at close to the speed of thought," as Klemp says, allows researchers to analyze complex storms bit by bit, without having to fly into them.

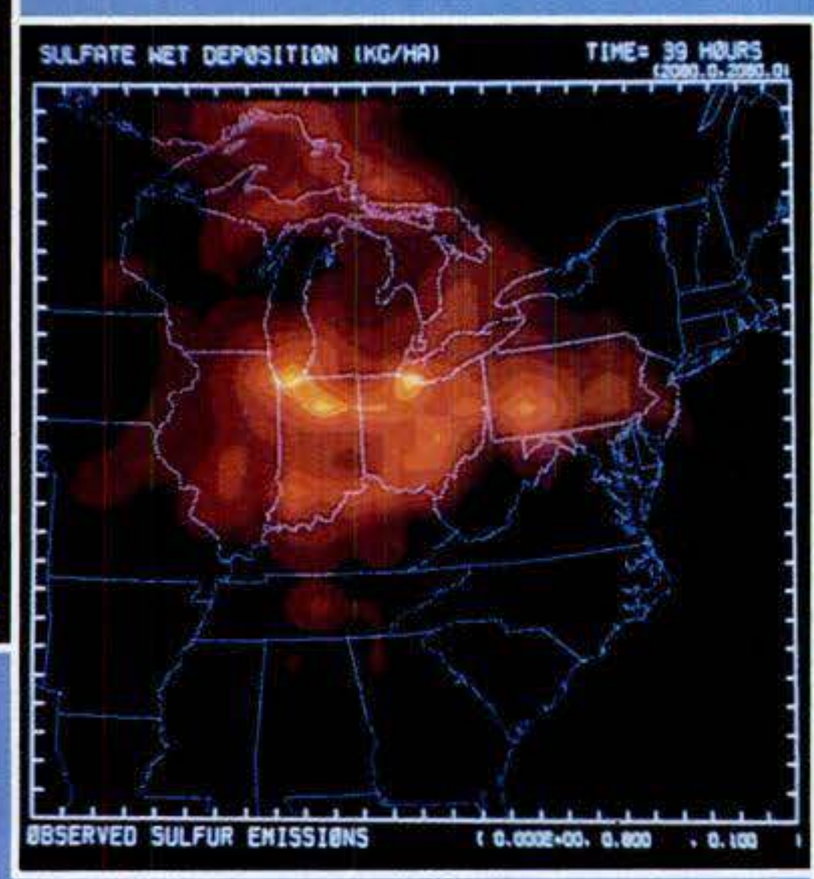
The left-hand image is of a supercell storm in its mature phase. Much to Klemp and Rotunno's surprise, this simulation persistently showed a wall cloud, a circular foot that sometimes projects below a massive storm cloud and is often the precursor of a tornado. The right-hand image shows cross sections of a mature supercell thunderstorm. The white arrows depict horizontal wind flow; red and green contours mark updraft and downdraft regions, respectively; the yellow line shows the storm's gust front, the boundary between cold and warm air; and the blue areas mark rainfall areas, lighter blue for heavier rain. The indentation seen in the red contours of the middle layer, often seen by radar in major storms, is called a hook echo. It frequently signals an impending tornado.



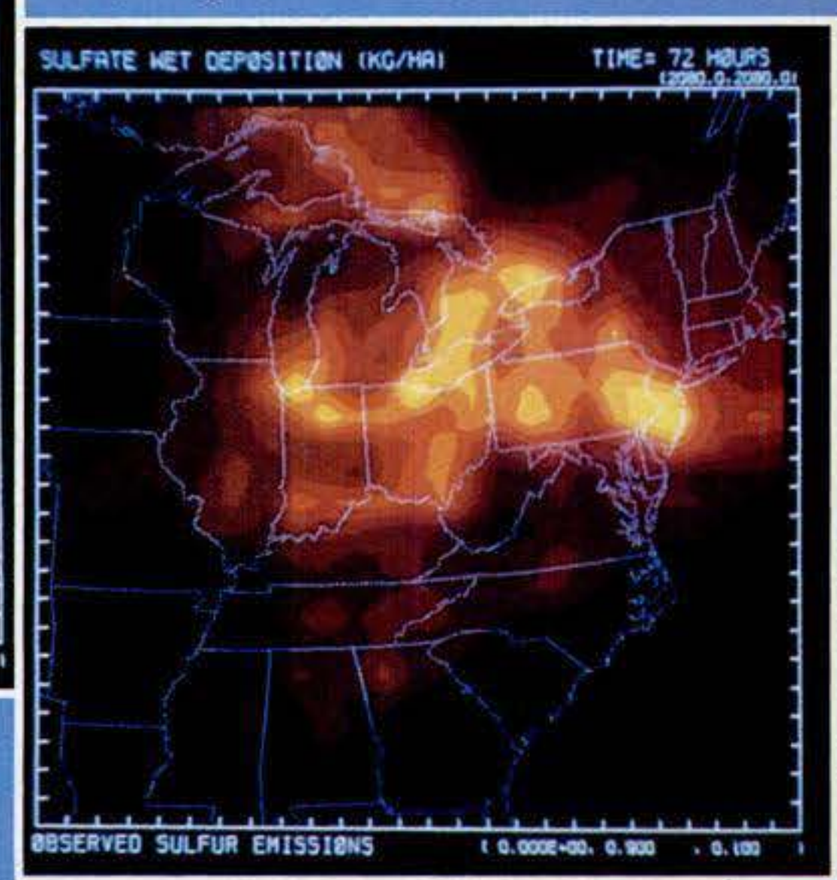
hallmarks. And one way to do that is through computer modeling.

This series of six supercomputer-generated images shows the development of a typical microburst over a 2-hr. period. In this sequence, cold dense air, shown in blue, drops rapidly to the ground, and then develops an intense, swirling vortex. The microburst model used was developed from sets of equations by Kelvin Droegemeier when he was a graduate student at the University of Illinois at Urbana-Champaign and by Professor Robert B. Wilhelmson, in research supported by the National Science Foundation. They used a Cray-1 supercomputer at the National Center for Atmospheric Research (NCAR) in Boulder, Colo., to model the dynamics of the microburst. The images were processed at the University of Illinois, where future simulations are planned for the Cray X-MP at the University's National Center for Supercomputing Applications. This is one of five national supercomputing centers recently established around the United States by the National Science Foundation in an effort to bolster U.S. research ability.

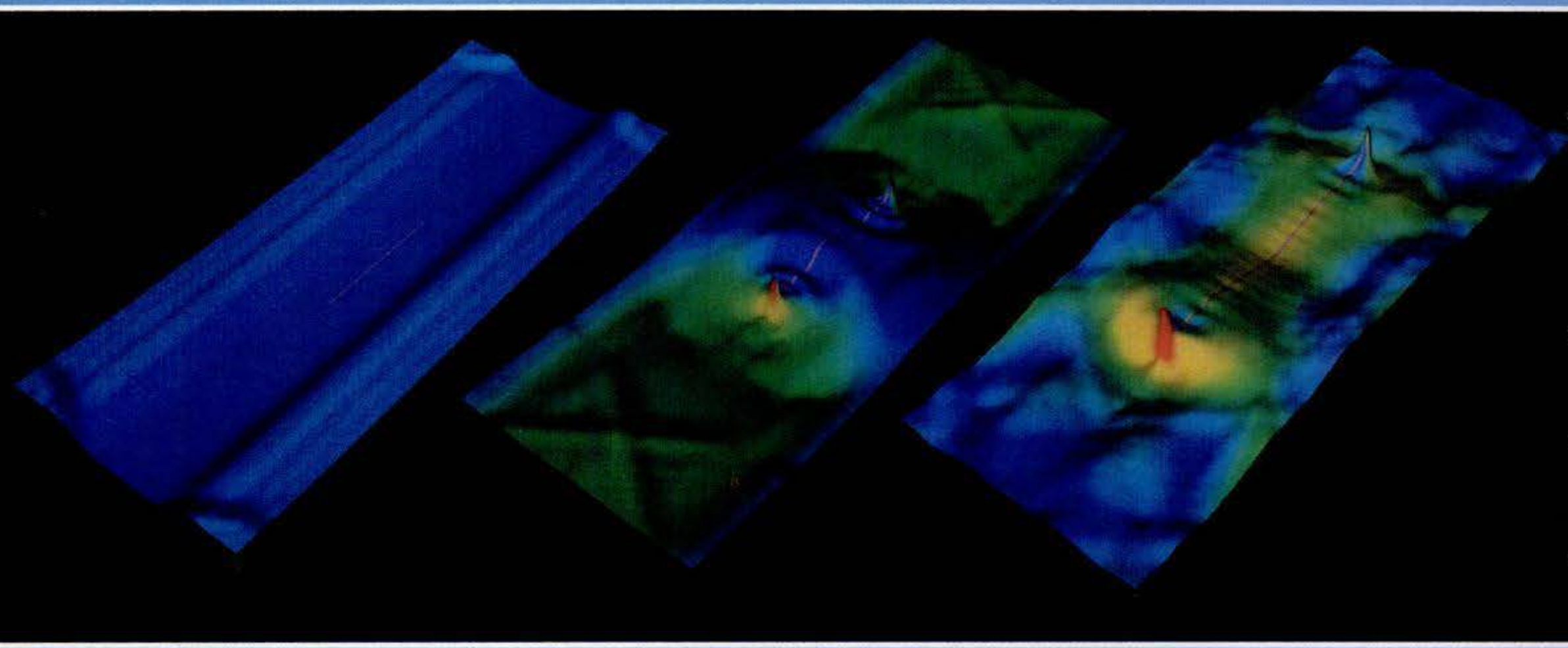




ACID RAIN in the U.S.—just what is its relation to emissions of sulfur dioxide from power plants? In a joint project with the EPA, NCAR scientists led by Julius Chang used a Cray to model three days in 1981, then compared the predicted acid rain deposition with actual measurements at 36 locations. Results: right on the button.

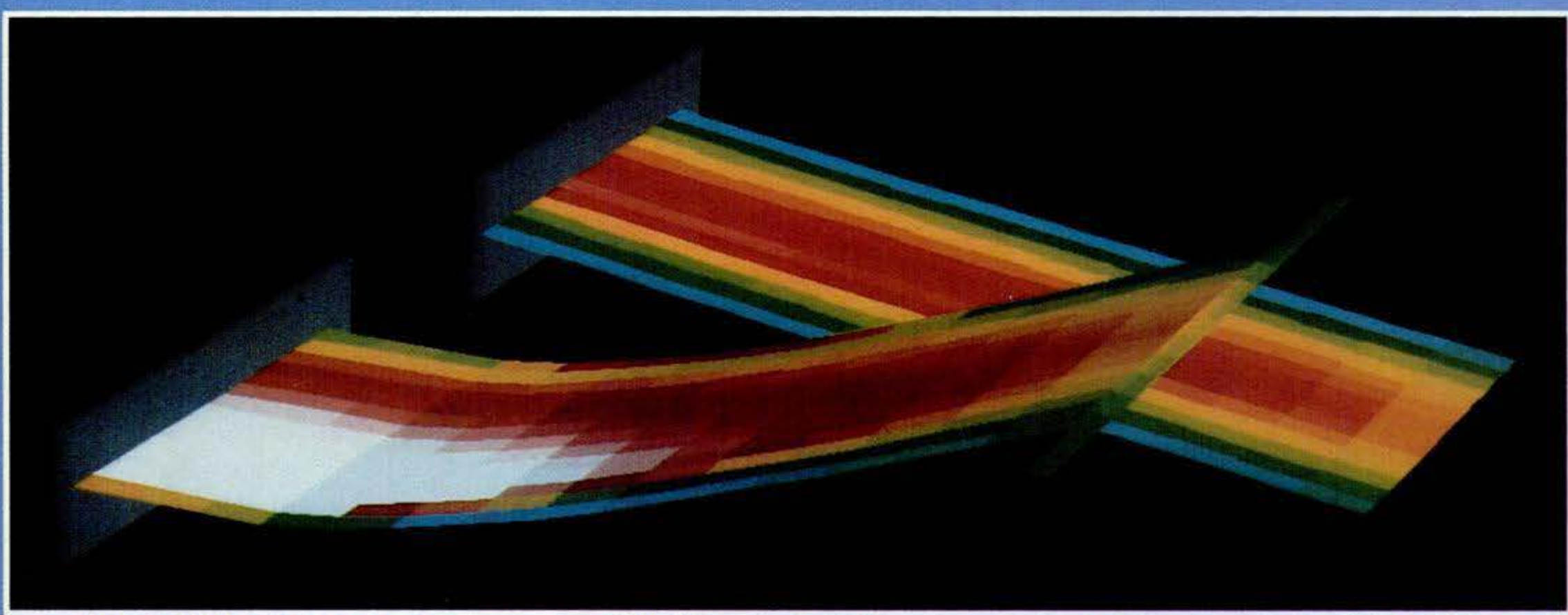


MATERIALS



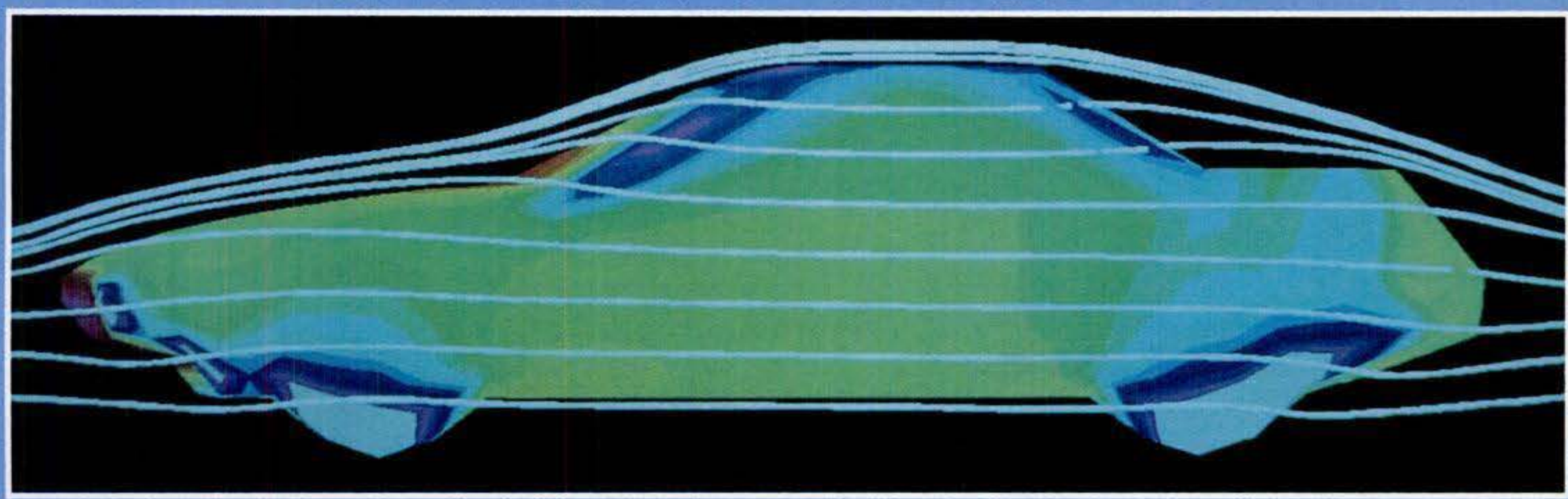
WHY DOES A CRACK racing through a metal plate at 2,000 mph generate an extremely variable stress in the metal? A few years ago, Robert Haber and his colleagues in the civil engineering department at the University of Illinois at Urbana-Champaign were stumped by this problem. Haber specializes in the propagation of cracks, which can endanger such critical structures as oil pipelines and nuclear-reactor pressure vessels. Supported by the National Science Foundation and Cray Research, Inc., his team developed this supercomputer graphics action sequence of the mysterious event. "With computer graphics," says Haber, "we were able to see that shock waves generated by the crack, like ripples moving out from a pebble dropped in a pond, were reflecting off the plate edges, thus creating the 'ringing' effect." The interference patterns of the shock waves are clearly seen in the second and third images; the reddish spikes in the last image indicate peaks in kinetic energy. It would have taken a year just to read all the numbers generated by one such computer simulation, says Haber. With computer graphics availability, the answer to the problem was immediately obvious. His colleagues on the project were Hyun Koh and Haesung Lee.

AERODYNAMICS

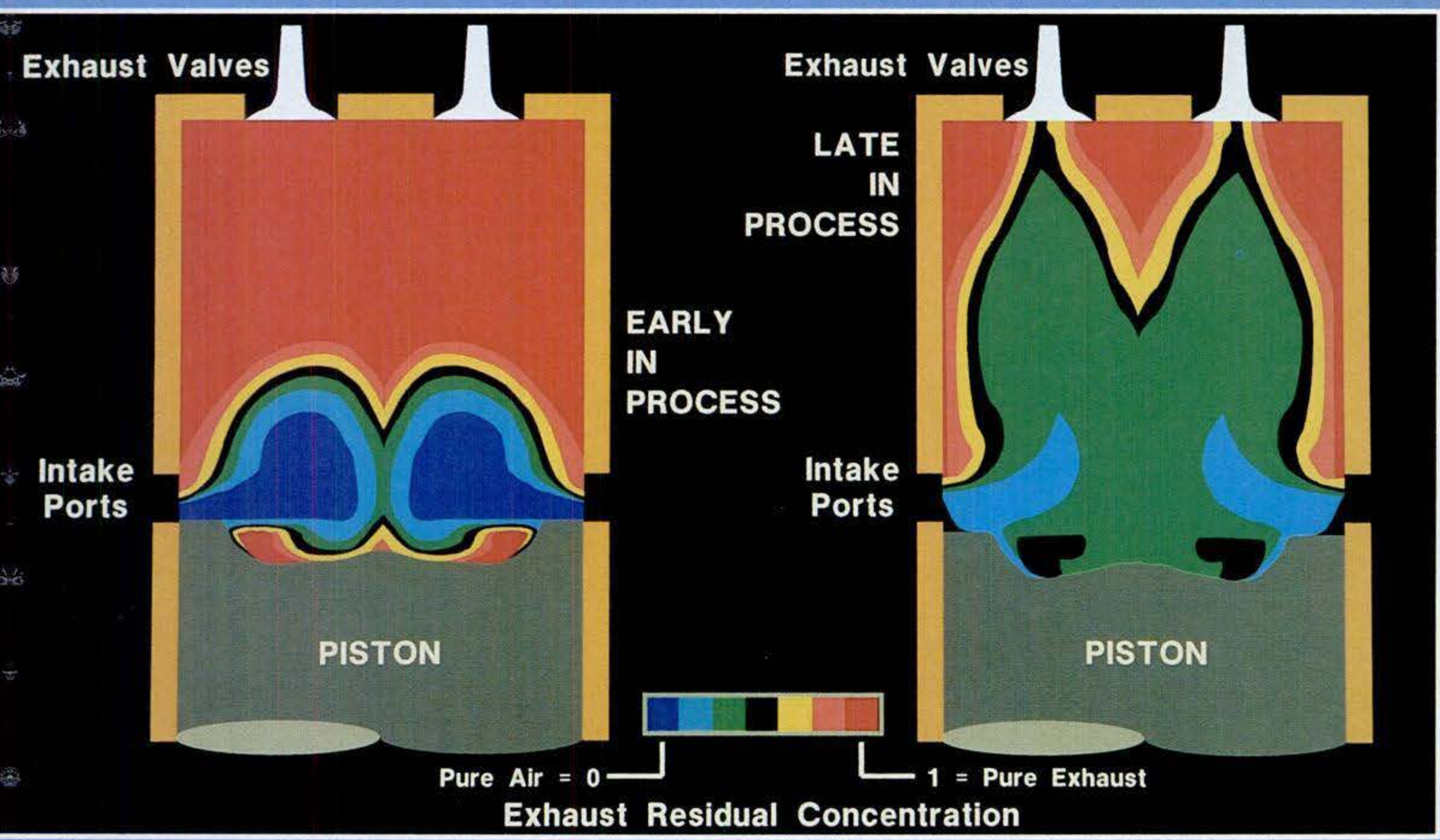


HOW DOES A GIVEN WING behave aeroelastically at transonic aircraft speeds if you hang an extra structural element such as a fuel pod or missile on the wing tip? (Designers call such add-ons "tip stores.") Would the wing, and therefore the aircraft, become unstable? That was the concern of G. P. Guruswamy, an aerodynamicist at Sterling Software, a contractor to NASA Ames Research Center. To find out, he modeled the behavior of a wing with and without a tip store, using one of the supercomputers at NASA Ames Applied Computational Aerodynamics Branch. The image above tells the story: At Mach 0.875, or something under 700 mph, the wing with the tip store (the green strip) has flexed dangerously and is about to fail. (Colors are coded to represent air pressures on the upper surface.) "Our study won't replace a wind-tunnel test," says Guruswamy, "but it does enable us to locate trouble spots early on."

AUTOMOTIVE



COEFFICIENT OF DRAG, or streamlining, an important factor in fuel economy and noise level, has been simulated for a Pontiac Fiero in this computer graphic. C. A. Koromilas of the Fluid Mechanics Department at General Motors Research Laboratories computed this field flow on a Cray-1S/2300 supercomputer. The surface colors indicate air-pressure level from red, the highest, to purple, the lowest. Streamlines track the flow of air over the car's body.



COMBUSTION PROCESSES inside engines are still poorly understood, despite the production of successful engine designs. This GM simulation, also done on a Cray, models the workings of a two-stroke-cycle engine with a type of scavenging (replacement of exhaust gases by a fresh charge) called uniflow: The fresh charge enters through intake ports at the bottom of the cylinder; the exhaust leaves through four valves in the cylinder head.

The cross-sectional view on the left shows what is happening near the beginning of the scavenging process. The fresh charge has pushed out a mass of exhaust gases and formed a bulb-shaped region in which pure fresh charge, shown in blue, is surrounded by shells of mixtures of fresh charge and exhaust. Each shell represents all regions of the cylinder that contain similar mixture ratios of exhaust gases to fresh charge, as indicated by the color code at the bottom of the picture.

Later in the scavenging process, as shown by the right-hand cross-sectional view, more fresh charge has entered the cylinder, thereby pushing out most of the exhaust gases except for those in two regions. These consist of an annular region along and around the cylinder wall, and another region in the center of the cylinder near the top.

By carrying out such supercomputer simulations for different inlet configurations, researchers can determine the amount and distribution of the remaining exhaust gases. These calculations can yield insights useful to future engine design improvements.

JETS!

New jet-drive outboards from Yamaha resist weed fouling, and make life safer for water skiers and aquatic wildlife. But they pay a penalty in efficiency.

By BILL McKEOWN

BATON ROUGE, LA.

Cruising on the plane at an indicated 36 miles per hour, I glance over the stern of the 18-foot aluminum boat. A fire-hose-size stream of water is shooting from the lower end of the outboard just above the surface of the murky backwater. Without a propeller churning away underwater, there's no torque resistance at all, and steering is equally easy right or left. I crank the boat into a tight circle about 30 feet wide and notice that the motor is free of the expected cavitation and over-revving that occur when a prop surfaces and chops air.

I'm testing the 115-horsepower water-jet outboard at Yamaha Motor Corp. USA's new development center hidden in the bayous near here. It's the second biggest in a five-model line that ranges from 40 to 200 hp. These new outboards—like the inboard jet drives that have been around for some time—let you skim over shallow-water shoals and mud flats without a thought of propeller blades being smashed against the bottom or hopelessly entwined in weeds and fishing lines. Swimmers, water skiers, and Florida's beleaguered manatees (those amiable walrus-like sea mammals) can breathe easier, too, knowing there's no spinning prop to worry about.

Reverse on these jet outboards is simple—and effective. Hinged below the water-outlet nozzle is a cup that swings up into the water flow to direct water forward, thus reversing the boat.

Piloting a water-jet boat does require the helmsman to change some

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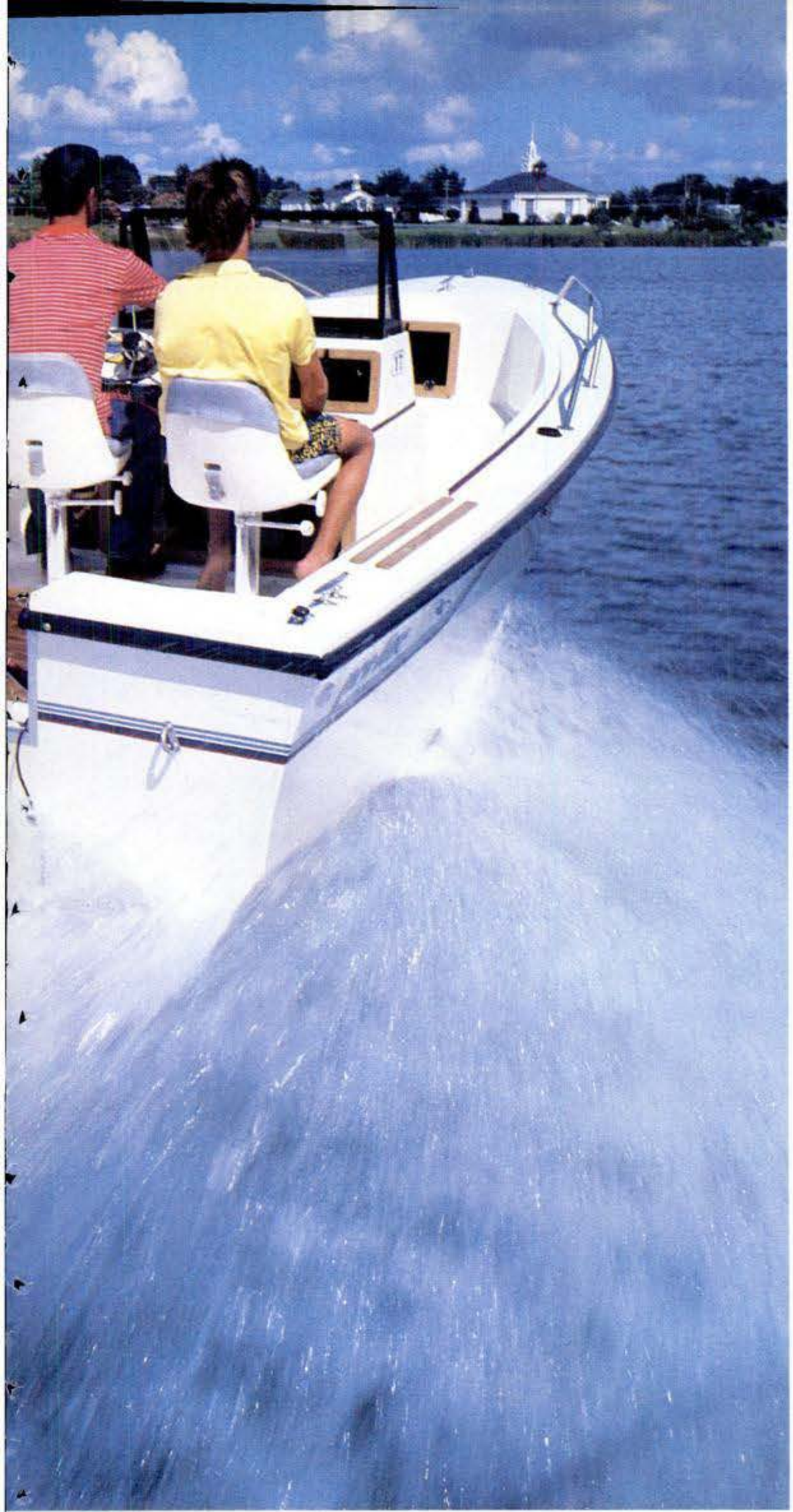
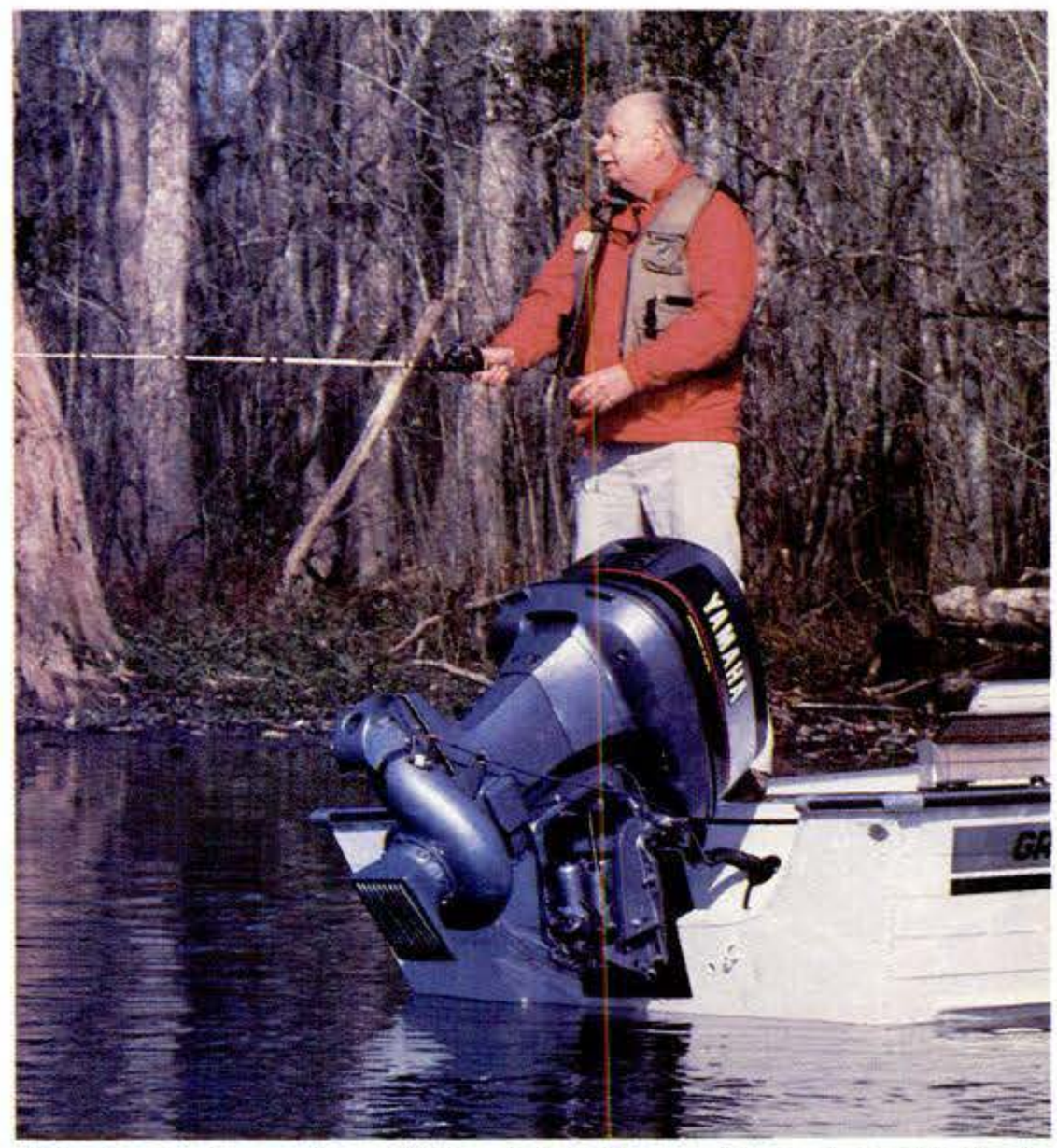
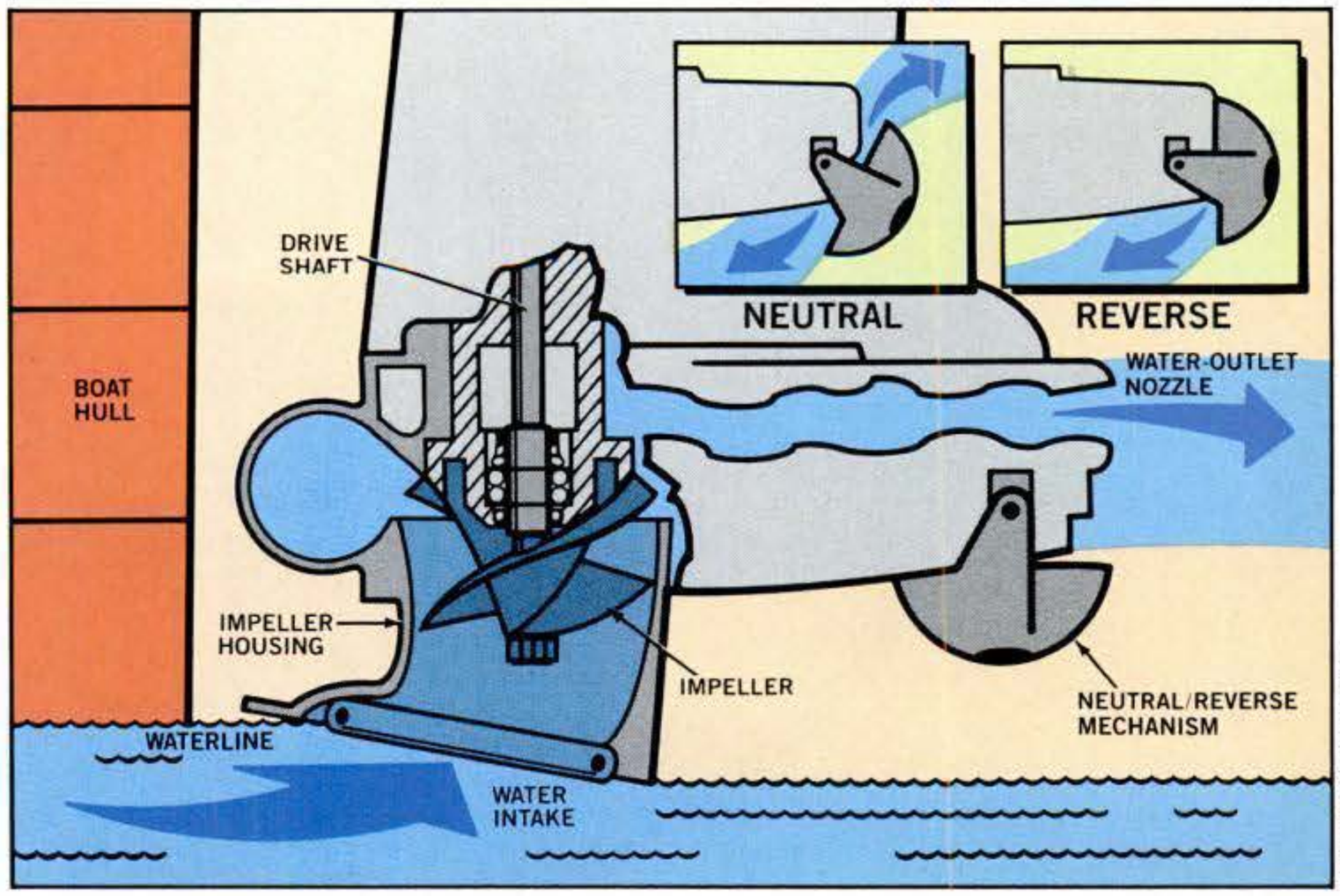




At planing speed, a 90-hp jet-drive outboard (left) blasts out a powerful stream of water just above the waterline. Only the engine's water intake is submerged, giving the boat exceptionally shallow draft. Pausing for some angling, the author (above) has tilted the test boat's 115-hp motor forward, revealing the impeller housing and the bottom-mounted water-intake grill. Should floating weeds clog the intake, reducing the throttle to idle will let them wash away, says Yamaha Motor Corp. USA (Box 6555, Cypress, Calif. 90630). Practical jokers will appreciate this feature: The lower unit can be trimmed out to arc skyward an impressive rooster tail of water that would certainly wash down anyone following close astern. The 40-, 50-, and 90-hp water-jet models use in-line three-cylinder engines. The 115-hp version has a V4 configuration, while the 200-hp motor is a V6. Prices range from $3,162 to $8,956. The diagram (below) shows a vertical-axis impeller, which draws water up through the intake grill and forces it out the nozzle. A movable cup (inset) swings partway into the jet stream for neutral-speed position. In reverse, it diverts the stream forward, permitting the boat to be steered backward.

habits. Unlike a conventional inboard or prop-style outboard-powered boat —where you chop the throttle and steer away to dodge something ahead —with the jet drive, you keep the power on and turn. *Then* you cut the throttle. Otherwise you will steer without thrust and keep going straight ahead while turning the wheel.

Is the jet outboard going to replace the prop jobs? Definitely not. When it comes to performance, Les Hulfachor, Yamaha's test facility manager, figures comparably rated prop outboards are about 25 to 30 percent more efficient. But for those who need them, the special shallow-water capabilities and safety benefits of the jet drives will far outweigh the loss in top-end speed and load capacity. PS



DRAWING BY NINA WALLACE

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ERASABLE

Optical discs can store 100 times more information than can regular magnetic floppy diskettes, and 10 times more than hard disks. Now a dramatic advance: The newest generation of these high-capacity discs can be erased and reused repeatedly.

By NORMAN METZGER and NAOMI J. FREUNDLICH
Drawings by Mitchell J. Albala

"That's our first half-height drive," Fred Geyer, general manager of magneto-optic drive and media at Verbatim Corp., says with a laugh. He's holding a plywood-and-cardboard mock-up of a floppy-diskette drive. "In typical Silicon Valley tradition, this was made in a garage by the eleven-year-old son of a colleague," Geyer adds.

Geyer then produces a working prototype version of the boy's low-tech mock-up. He pops a 3½-inch disc encased in a knuckle-thick plastic sleeve into the drive, then types the words POPULAR SCIENCE, which appear on a CRT screen. After he keys in a write command, two blips flash across an oscilloscope screen nearby. One blip indicates erasure of previous data, and the second signals the writing of POPULAR SCIENCE.

Pretty standard stuff, right? Actually, Geyer had just demonstrated a dramatic new technical advance in information processing. That was no ordinary 3½-inch microfloppy magnetic diskette [PS, Dec. '83] but rather an optical disc that can hold a whopping 50 megabytes of data, or about 100 times more information than conventional floppies. And that was no ordinary drive: It was equipped with a laser-and-magnet head that reads and writes information optically and magnetically. This system from Verbatim, a subsidiary of Eastman Kodak Co., is one of the first fully erasable optical discs on which you can write, read, and erase endlessly.

Many other firms are entering the race, employing several erasable technologies. And a second generation of drives is already on the drawing boards, designed to overcome some limitations of the first models slated for marketing soon. Potential applications include

- High-capacity data storage for desk-top computers.
- Storage of torrents of satellite data in real time—including video movies.
- Home compact-disc audio recording.

A variety of laser-based optical-disc systems are already in use. The most

PHOTO BY GREG SHARKO

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optical discs

familiar kind of optical discs are read-only versions—the compact music disc or Laservision videodisc. Digital information is imprinted on these discs by a laser that leaves permanent marks—bumps or indentations—on the disc surface.

The development of an erasable optical disc dramatically expands the utility of this super-high-density storage medium. It essentially means that optical discs can take the place of magnetic floppy diskettes or the more capacious hard disks (Winchesters), yet can be treated just like floppies. You can make simple copies from disc to disc, eliminating the tedious tape backups needed for Winchesters [PS, Oct. '82]. The enormous capacity of optical discs is attractive: 50 megabytes on Verbatim's 3½-inch disc, and 250 megabytes—10 times as much data as a conventional Winchester—claimed for 5¼-inch erasable optical discs. But the benefits extend beyond storage capacity. Indeed, many experts see a convergence in the amount of data storable on magnetic and optical discs. In the end, what will sell erasable optical technology is the fear of losing data with conventional magnetic media.

Preventing crashes

In Winchesters, the gap between the "flying" read-write head and the disk surface is about one-third of the wavelength of green light. That's been compared to a 747 flying 500 miles an hour 1/10 inch above the ground. A slight surface imperfection—even dust—can cause the head to "crash," or land on the recording surface, destroying the Winchester and the data it held. In erasable optical recording, the head is several thousand times farther away from the disc, thus eliminating the crash problem.

According to Edward Rothchild of Rothchild Consultants, a San Francisco firm that publishes *Optical Memory News,* more than 50 companies around the world are designing erasable discs and drives, using several different technologies.

The first erasable optical systems to hit the market will be those that use a hybrid magneto-optic recording technology (see box). Closely following these systems will be those that employ a technology called phase change. In these systems, information is stored on discs made from materials that can be switched from crystalline to amorphous states with a heating laser (see Phase-Change box). Farther down the

Continued

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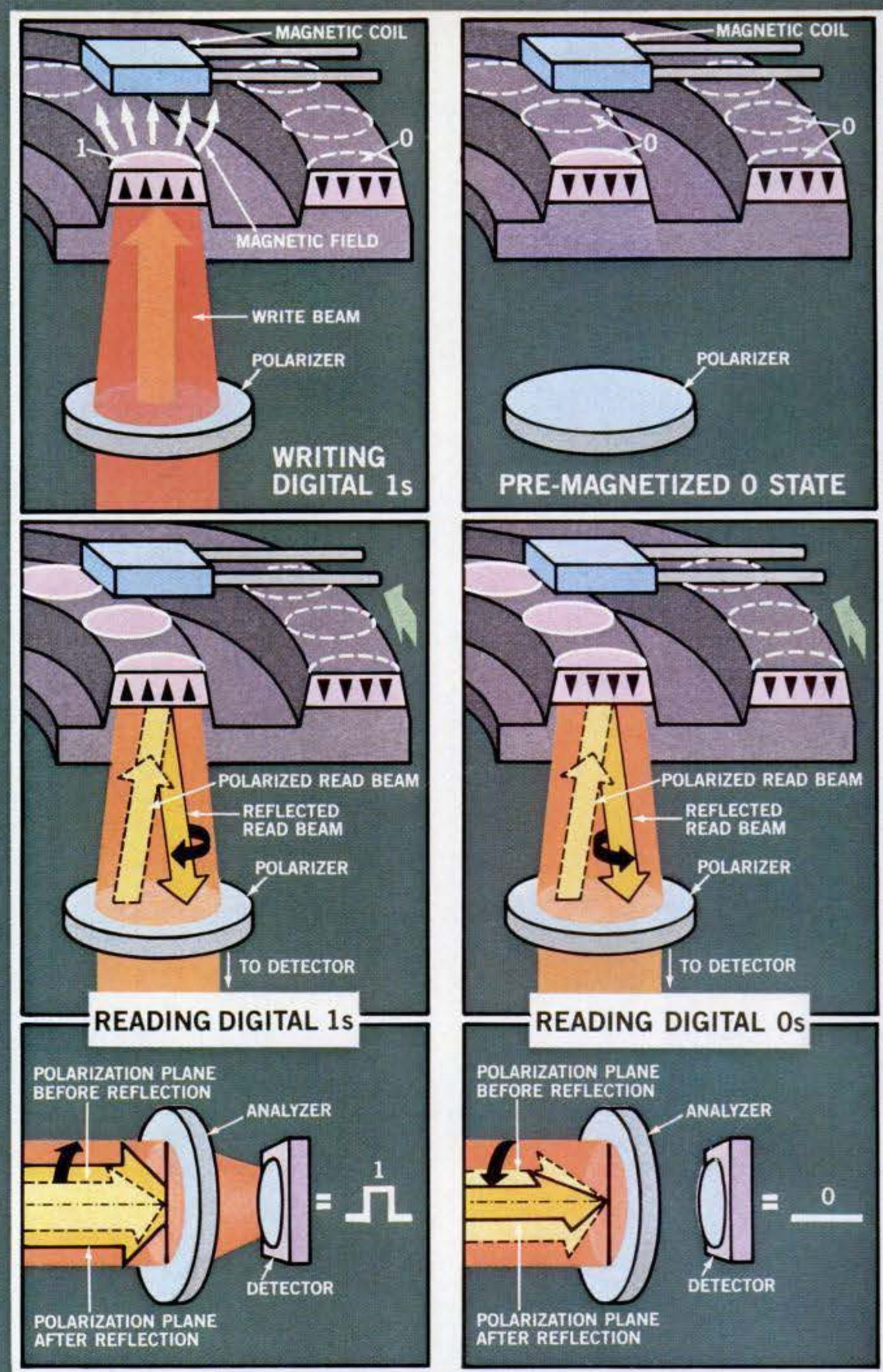
Magneto-optic recording

As the name suggests, magneto-optic recording depends on a combination of magnetic and optical effects. Information is stored magnetically, in oppositely oriented magnetic domains, or "bars." To write digital data corresponding to the on, or 1, state that computers can understand, a high-power writing laser is used to heat up a tiny spot on the disc's magnetic film. This lowers the coercivity, or resistance, of the magnetic domains to the magnetic field switched on from above, and the polarity of the spot is reversed. In the diagrams, areas where the domains are switched upward represent a 1, while premagnetized areas without this switched polarity are 0s, or the digital off state (drawing, top right). To read-out which areas are 1s or 0s, a low-power beam of polarized laser light is reflected off the film (drawings center). Electromagnetic light waves have both magnetic and electric components oriented in a variety of planes. A polarizer in front of the combination write-read laser diode allows only light waves traveling in one plane, shown by arrows representing the electric component, to pass. When this polarized beam strikes the switched-polarity area for a digital 1, it is reflected, but with its plane of polarity twisted slightly in one direction. (The magnetic component of the light wave interacts with the magnetic field of the disc material—a phenomenon called the Kerr magneto-optic effect.) This twisting of the polarization plane enables the beam to pass through the analyzer, an optical element oriented here to block light unless its polarization plane is vertical. The readout beam then strikes a photodiode light detector, registering the presence of a digital 1. When the read beam reflects from a digital 0 region (middle drawing, far right), the disc's magnetic field twists the reflected beam in the opposite direction. Because the beam is now blocked by the analyzer, a digital 0 registers. The data are erased by a reversal of the magnetic field and a quick laser pulse.



road are dye-polymer systems. The media in this recording technology are dual organic polymer layers infused with dyes that absorb laser light of different frequencies (see Dye-Polymer box). Information is stored in deformations of the polymer layers.

Each recording technology has its advantages, but the final goal for all is to develop an optical system that performs as well as or better than magnetic media. That means generating a well-defined mark that stays in place but can be instantly erased from the disc. That also means no permanent pits or bumps as with write-once optical discs. Optical-disc drives must also be able to write data and read it back at speeds comparable with those of Winchesters.

So far that's been one knock against magneto-optic erasable systems: Both their write and read times are too slow. The overwrite rates (erasing and writing over existing data) are slow in magneto-optic systems because the magnetic field, applied as data are erased, cannot be switched fast enough. Instead of erasing data and instantly recording new data in the same spot (as with magnetic systems and dye-polymer and phase-change media), a full disc revolution is needed before new data can be recorded.

But researchers Mark Kryder and Han-Ping D. Shieh at Carnegie-Mellon University's Technology Center have devised a solution to this direct overwrite problem. Because the problem with instant overwrite was the inability to switch the magnetic field rapidly enough, they decided to try to eliminate the necessity for the magnetic field entirely. Their approach was to look for a thin-film composition that, when paired with the right laser pulse, would allow erasure without an external magnetic field. In their lab they tried depositing various blends of a rare-earth element, terbium, with cobalt and iron onto glass bases, and coating these films with a protective layer of silicon dioxide.

After several tries, Kryder and Shieh found their formula: Tiny pulses of 12-milliwatt laser light, focused to a one-micrometer point and lasting only 80 billionths of a second, hit the terbium-iron coating and instantly

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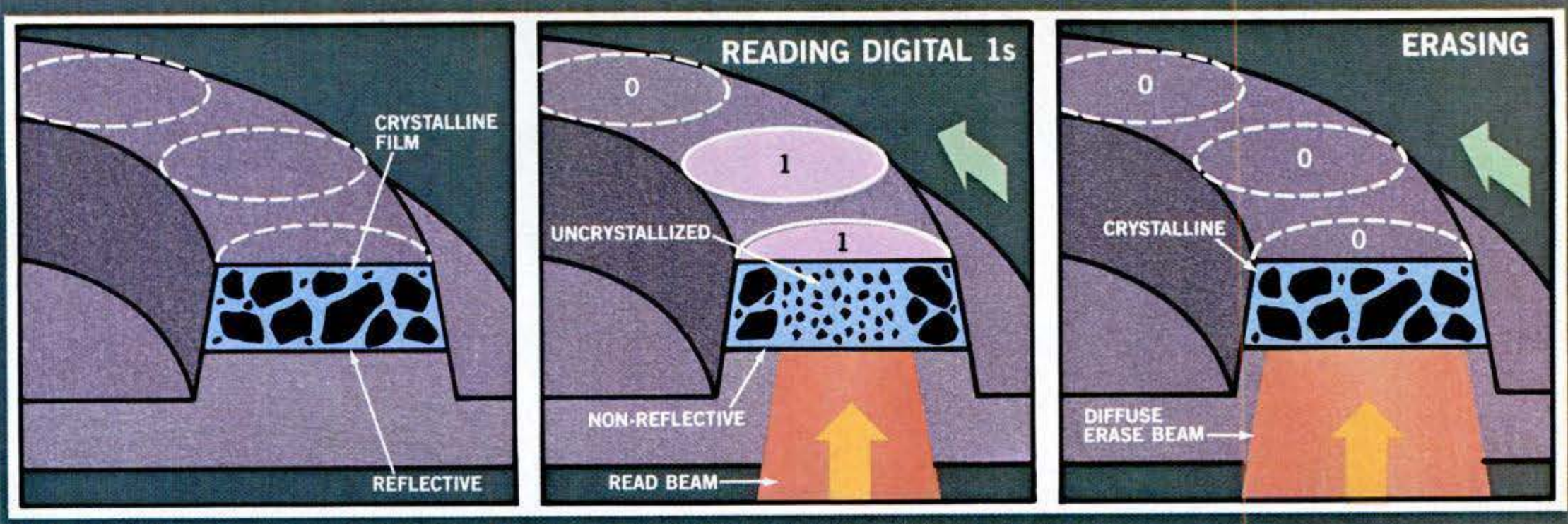
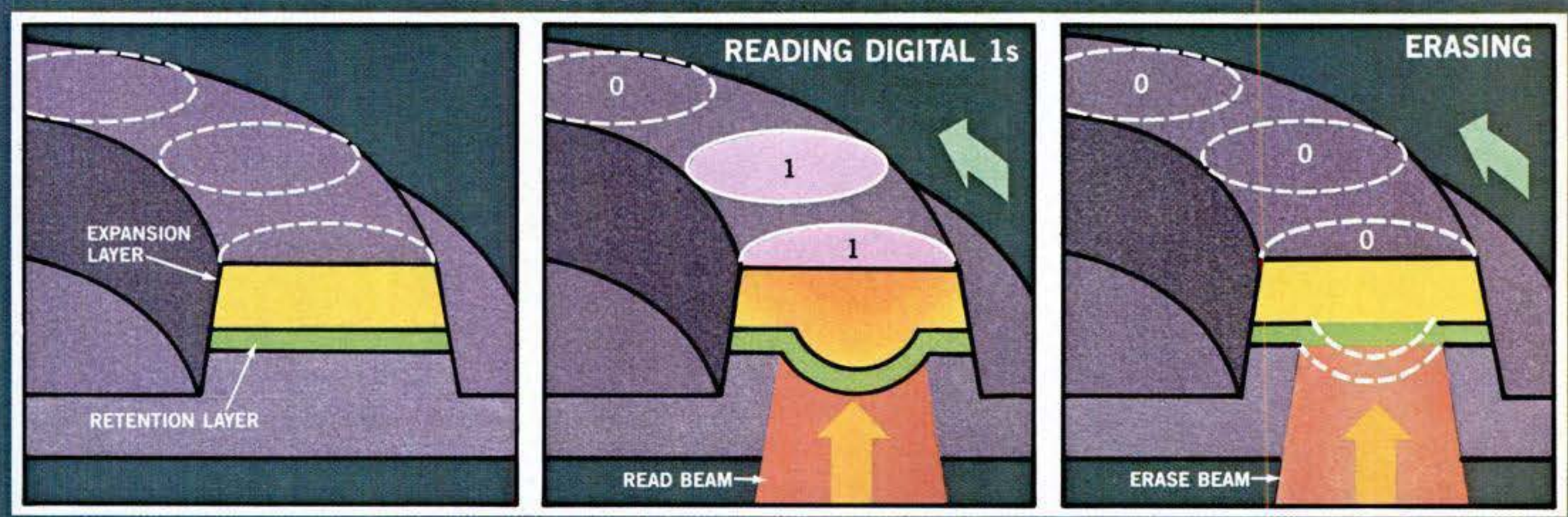
Phase-change recording



In phase-change recording, the recording material, typically a tellurium-based film, is continuously switched from crystalline (left) to a noncrystalline, or amorphous, state by heating with a write laser. Uncrystallized regions are non-reflective and create dark spots against very reflective crystalline regions. To record data, the tellurium media is heated quickly with a high-power laser. After cooling, the spot remains in the non-reflective amorphous form. To read recorded data (middle), a low-power laser beam is targeted on the disc and is reflected back to a detector in the optical head. When the beam hits an amorphous spot and no light is reflected back to the photodiode detector, a digital 1 is recorded. When the beam hits a crystallized region, the light is reflected back and a 0 is recorded. To erase data, the media is heated with a diffuse beam at lower power, which is spread over a wider physical area than the write laser. The net effect is that the overall temperature on the disc is much lower than when writing. A property of the tellurium material is that when it is slowly heated, it recrystallizes (right). There are two approaches to designing a phase-change system: a two-laser-beam approach—using one narrow-focus beam for writing and a widely dispersed beam for erasing—and an optical head with a single laser beam. The latter would require a laser pulse that could quickly (in several billionths of a second) alternate between two powers, one needed for writing and the other for recrystallizing or erasing. The single-beam approach, although more valuable in terms of cost-saving and speed, is also more difficult because it is not easy to accurately control the power of diode lasers over such small power increments. It's easy to go between 0 and 15 milliwatts (mW), but to be able to control laser power quickly and accurately between 15 mW and 20 mW is not yet possible.

Dye-polymer recording



Erasable dye-polymer recording systems resemble standard optical discs in that information is stored in a series of bumps on the disc surface. The difference is that these bumps are formed in polymer layers and are not permanent. Research on this recording mechanism lags behind magneto-optic and phase-change techniques because it is a relative newcomer. But if developed, each side of a 5¼-inch dye-polymer disc could have a storage capacity of about 500 megabytes and could hold up to one gigabyte (billion bytes) once the spot size of a laser can be decreased sufficiently. One promising system, being developed by Optical Data, Inc., uses two polymer layers—each sensitive to a different infrared wavelength (left). The larger, called the expansion layer, is composed of an elastomer containing a dye sensitive to light with an 840-nanometer (nm) wavelength. The other layer, called the retention layer, is infused with a dye sensitive to light at 780 nm. To write a digital 1, the expansion layer is heated with an 840-nm diode laser. The retention layer is transparent to this laser beam, but the expansion layer absorbs the light, heats up, expands, and pushes against the retention layer, deforming it. When the spot cools, the bump remains in the polymer layers, which stay laminated together. To read data, the writing laser is used at lower power. When the light hits a bump, it sends a scattered weak reflection back to the detector, signaling a digital 1 (middle). Where the surface is flat, all light is reflected back to the detector, signaling a digital 0. Erasing is completed by using a second laser beam of 780 nm. This light is absorbed by the dye in the retention layer, but not the expansion layer. This softens the retention layer, reducing its modulus of elasticity. Energy still stored in the expansion layer allows it to pull itself back down, bringing the retention layer with it (right).

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They're better, so they can be bigger: replacement

AFTER

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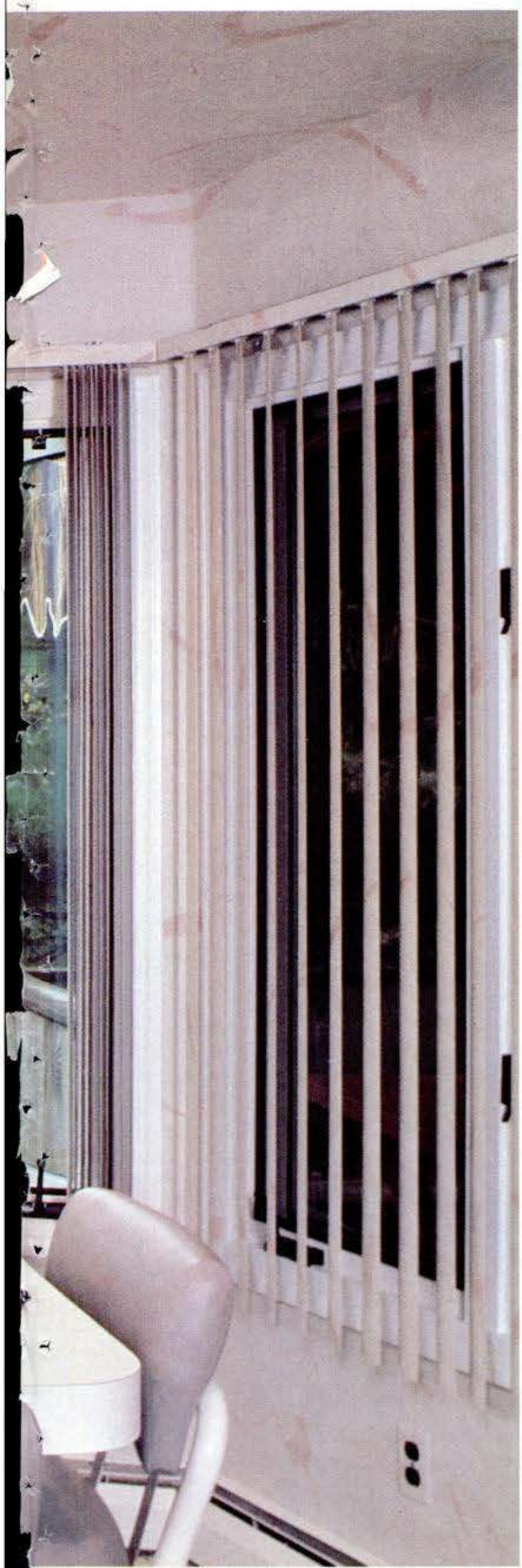
windows

If cold and dank were in style, this dining bay would have been a showcase. The cure: Replace the aluminum sliders with larger, low-emissivity casements to create a bright breakfast nook that's comfortable all year.



By MARC BRETT
Photos by Greg Sharko

You've heard of winter wastelands? That was the dining bay off my kitchen. Its four 18-year-old windows leaked enough winter chill to make the tundra seem a cozy place for breakfast by comparison.

My solution? I replaced the old bay windows with new double-glazed units featuring low-emissivity glass. I also beefed up the insulation in the wall areas and glued rigid foam under the projecting floor. The results were far better than I anticipated: no air infiltration, no fabric-damaging ultraviolet rays, high energy efficiency in both summer and winter, and—perfect for breakfast—lots of light. Because the new windows *are* more efficient, I could go for a larger glass area.

Done with mirrors

I selected four clad wood casement windows manufactured by Caradco. Each unit has a left- and right-hinged sash swing and measures five feet high by four feet wide with two 19-inch-wide glass panes. The wood frames are encased in heavy extruded aluminum, and all frame parts are treated with a water repellent, preservative, and insect toxicant.

The insulating glass has a ¾-inch dual seal with ½-inch air space to provide maximum insulation. By combining a rigid vinyl leaf weatherstripping on the sash and a flexible one-piece vinyl bulb system on the frame, Caradco virtually shuts down air filtration at 0.03 cubic foot per minute per foot of linear crack.

For still greater comfort and energy efficiency, I specified low-emissivity (low-E) glass. A material with low emissivity resists absorbing energy, so it has a greater ability to reduce heat loss. Low-E glass results in a 20-percent lower U-value, or a higher R-value—meaning greater resistance to the passage of heat through a window unit. Low-E windows pass light and

Continued

Taller windows transformed this kitchen dinette, both inside and out. Structural headers weren't disturbed—the new windows set closer to the floor. Note in the exterior views that, while he was at it, the author also replaced a plain-Jane window in the living room to the right, installing a handsome four-pane bay. For a floor plan and installation tips, turn the page.

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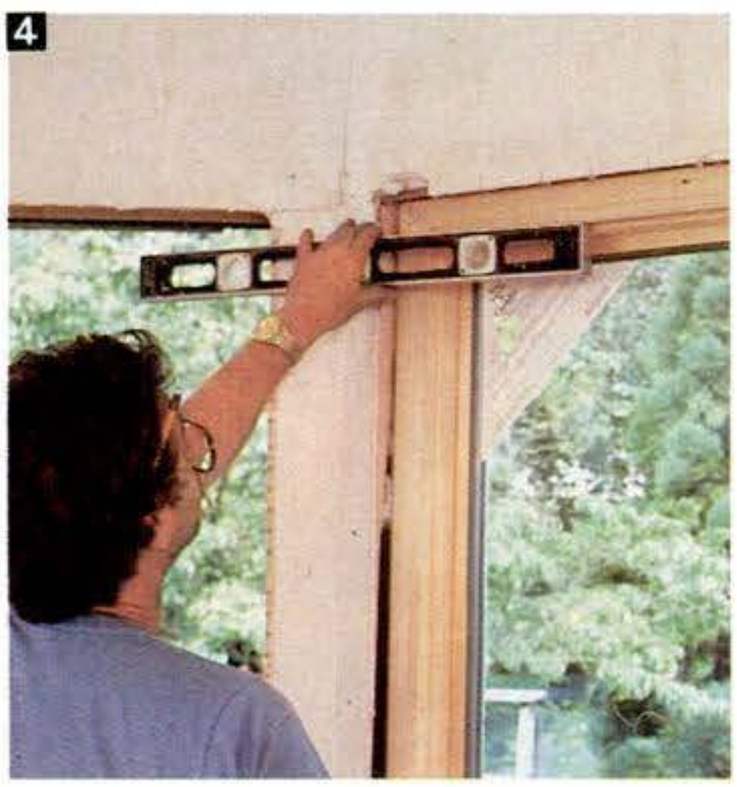

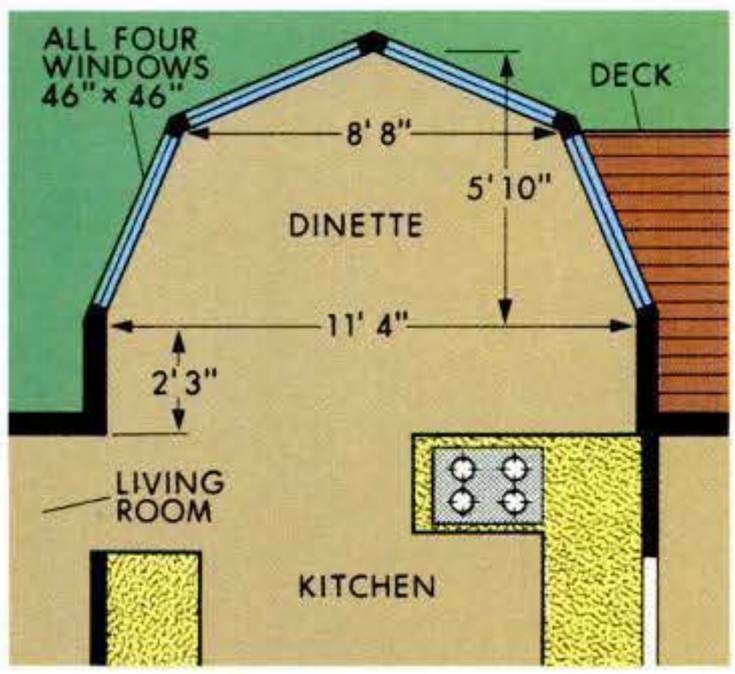

1 Reciprocating saw is used to deepen the rough window opening. Cut through the bottom sill, then pry back drywall to make sure no wiring or plumbing is in the way.
2 Plastic sheet provides a vapor barrier and additional insulation. Wrap it around the opening and staple.
3 Install the windows from outside.
4 Be sure the window is level to prevent leaks and possible structural problems. Shim as needed.
Dimensions of the dining bay are shown at left. The existing structure wasn't altered; only the window openings were enlarged.

heat from the sun, but once the energy enters the house, the low-E coating keeps the heat from escaping back through the glass.

Low-emissivity glass is highly reflective, rather like a mirror. In winter the coated glass reflects and traps heat created by the home heating system. In summer or in warm-weather areas the coated glass reflects the sun's rays, reducing the amount of heat entering the room.

Because the surface of the glass facing the room is kept warm, there is less likelihood of condensation. Window drafts caused by cool air falling down the glass surface are eliminated. And because low-E glass inhibits the transmission of ultraviolet light, interior fabrics—curtains and furniture—won't fade.

Find a friend

Removing the existing windows and replacing them with the larger Caradco units required careful handling. I took on the job with the help of a professional contractor, Phil Gonsowski. The work is shown in the photos.

We used a long-bladed Milwaukee reciprocating saw to cut through the wall and enlarge the window openings. Cut the rough opening slightly larger than the window—about ¾ inch along the width and ½ inch along the height. The headers that run above windows are structural and should never be cut into. You deepen a rough opening by cutting away the sill, dropping the window closer to the floor. Trim back the cripple studs (2 × 4s installed beneath the existing window), and, after cutting the new opening to size, reinstall the rough sill.

Leave the window's shipping braces in place until the window is nailed squarely in the opening. The braces help support the frame during handling. Use shims or tapered shingles in the corners of the opening to shift the window into a level position, and secure it by nailing flanges all around. (Use galvanized nails so they won't rust.) Stuff fiberglass insulation around the perimeter of each window before adding the casing and sill.

Finish the interior molding and wood frame with paint or stain. Proper exterior repairs must be done to avoid a patched look. Brick and stucco exteriors pose special problems. You might want to hire a professional mason for those projects. PS

SELECTED MANUFACTURERS' ADDRESSES

Caradco Corp., Box 920, Rantoul IL 61866 (clad wood casement windows with low-E glass); **Contemporary Shells**, West Hempstead NY 11552 (upholstered kitchen chairs); **Graber Industries**, Middleton WI 53562 (vertical blinds); **Morton Jonap Ltd.**, Hicksville NY 11801 (wallcovering); **Paint Bucket**, Seaford NY 11783 (lamination)

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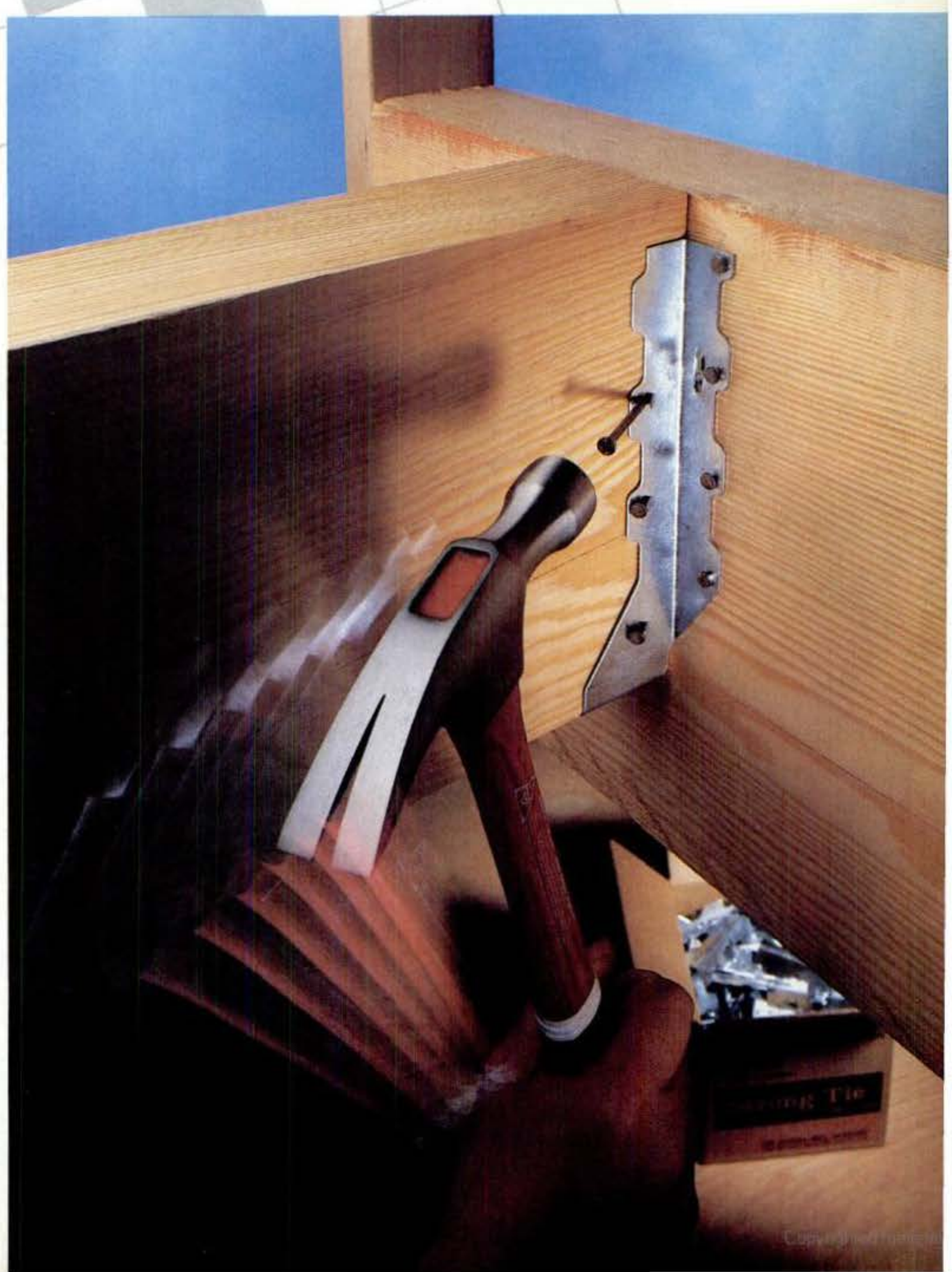
CLV CARPENTRY CONNECTORS

A bend here, a twist there, a tab on the other side: Metal connectors may look puzzling, but they uncomplicate carpentry and boost joint strength.



By PHIL McCAFFERTY
Drawings by David Dann

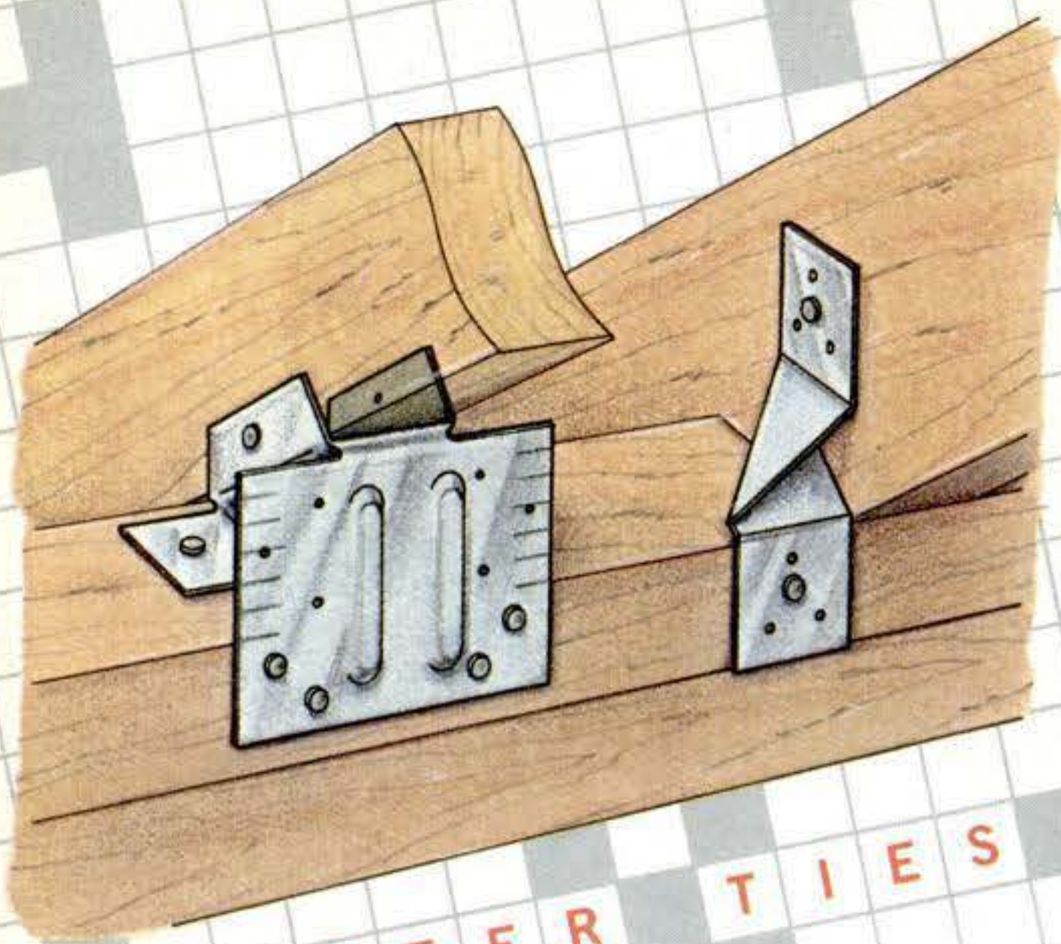
Strong joints are critical to any building project. But wood-to-wood joints often must be either toenailed—which is difficult for even a professional carpenter to do well—or nailed into inherently weak end grain.

Metal carpentry connectors—which range from simple plates to crazily convoluted forms—can free you from both of those sources of trouble. The connectors span the joint in two or three dimensions, and provide guide holes for nails, screws, or bolts. The fasteners are driven, in most cases, into the cross grain of dimensioned lumber, and are oriented so they will be in shear (at right angles to the stresses). In addition, some connectors hold the pieces together while you drive the fasteners. Finally, they reinforce the resulting joint.

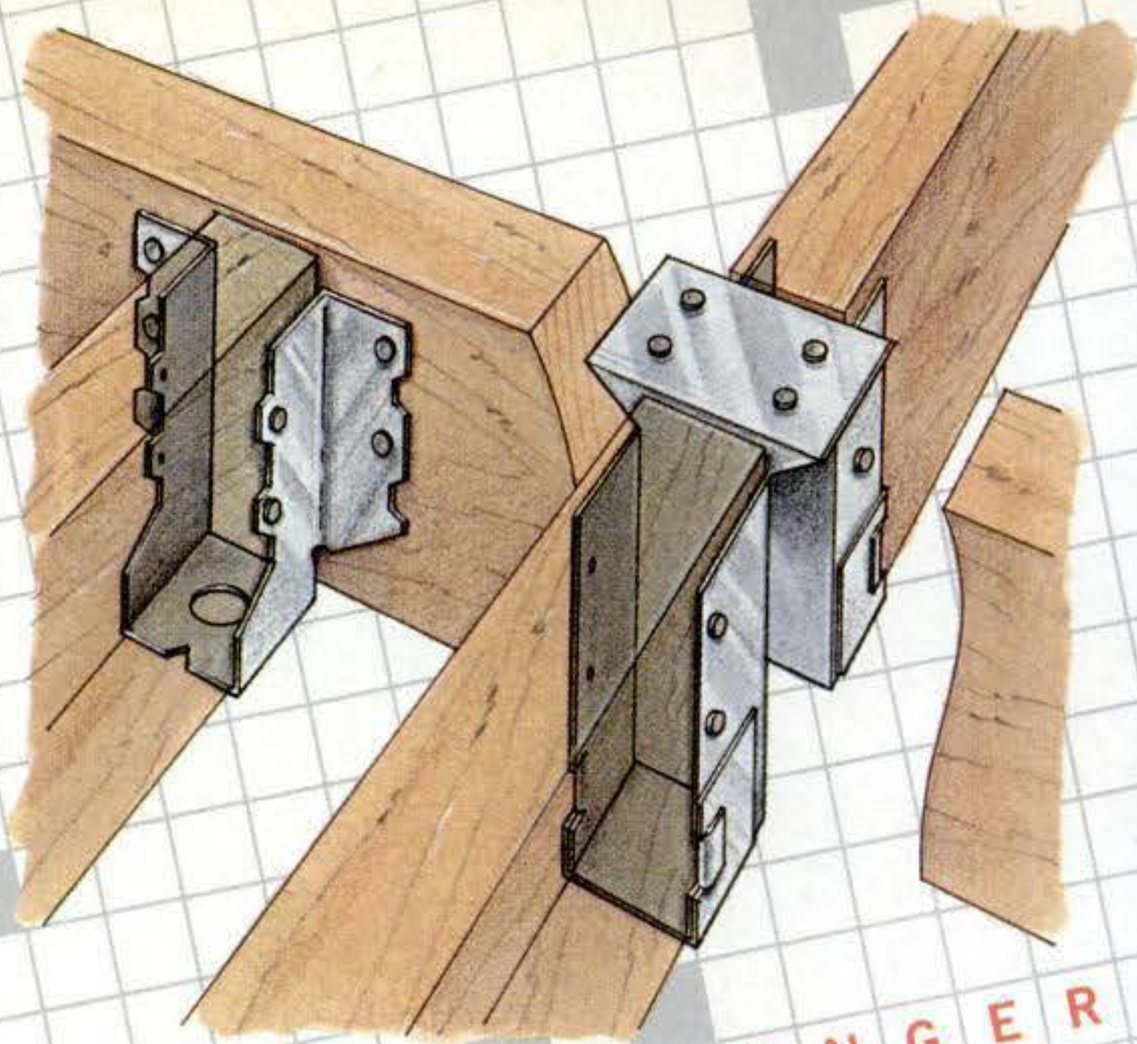
Carpentry connectors are made from steel—formed, punched, and in some cases welded to provide the configuration and strength required. Most are galvanized, but some are painted.

For just about any joint on almost any project (short of fine cabinetry), there is a suitable carpentry connector. Use them to build a hexagonal gazebo, fence, deck, addition, partition, storage building, or even casual furniture. Some are designed to join wood at angles other than 90 degrees. And some can be bent in different ways to do different jobs.

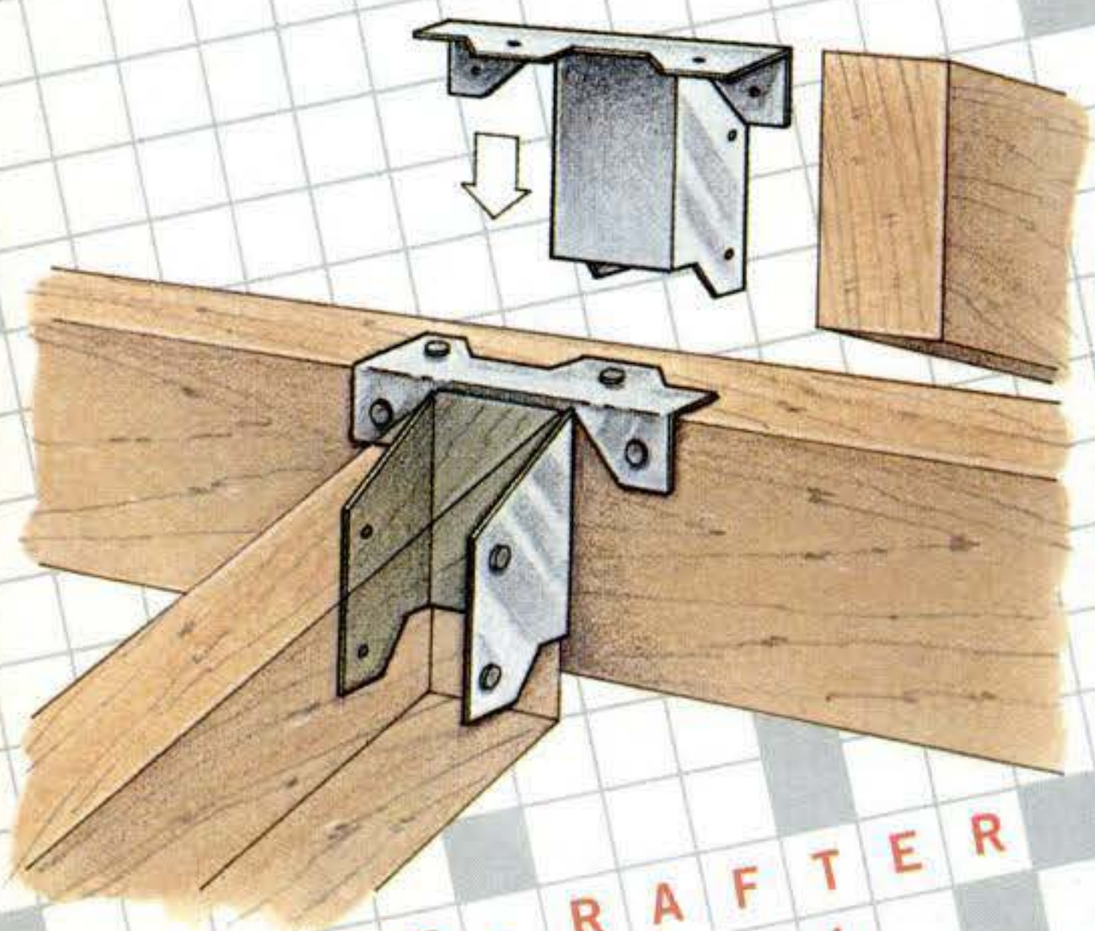
Continued



1 RAFTER TIES



2 JOIST HANGERS



5 RIDGE-RAFTER TIE

1 Rafter ties eliminate toenailing and increase resistance to wind uplift. The variable-pitch tie from Simpson Strong-Tie (left) is marked with the slope of rafters; just bend it to suit. The "reversible" tie (right) is for notched rafters. 2 Joist hangers come in sizes for all two-by (and doubled two-by) lumber, and in single (left) and saddle (right) configurations. Some have self-nailing cleats for quick locating. Pros often fasten all the hangers to beams, then drop joists in the troughs. 3 Post caps provide sturdy attachments for cross beams. 4 Post base, shown disassembled and assembled, connects a post to a concrete-embedded anchor bolt. A circular plate with various holes allows the position adjustment to mate with an out-of-line anchor bolt. A U-shaped rest keeps the post above the ground line. 5 Simpson Strong-Tie ridge-rafter connectors attach rafters to ridgepoles or ledgers. Note how the connectors interlock to give alignment control. This also gives correct nailing locations. 6 E-Z Builder right-angle connectors are enameled welded-steel brackets that allow lap-joining 2×4s. Use them to make log racks, workbenches, or tables. Holes accommodate nails, screws, bolts, or lag screws. 7 Barn Framer plates from Teco let you join 2×4s for a gambrel roof. The plates also serve as templates for cutting framing. They are a version of truss plates but call for bolts instead of nails.

Indeed, the variety of connectors available is almost overwhelming. One maker's catalog lists nearly 100 different types, each available in a variety of sizes. Most connectors are for dimensioned lumber—from 2×4s on up. Some are available for one-inch boards. Simple connectors cost just a few pennies; big, complicated ones cost several dollars.

"Originally, connectors were marketed to professionals—architects, engineers, builders, and carpenters," says Teco's Dave Norcross. Now Teco and others sell them through consumer channels as well. Check the selection at your hardware store or home center. Some savvy retailers have bins of connectors with drawings on the display that show how to use them. A store may also have handout booklets and plans that show suggested uses.

The drawings above illustrate some typical connectors and the joints they form. Here are some others to consider when you plan your next project:

- Crawford and Teco sell kits containing all the connectors you need to build decks in 14 different sizes.
- Starplate connectors for making hex-shaped buildings also come in kits ["Bolt-Plate Shelters for Your Yard," PS, July '85]. The hardware forms all the odd-angle joints. You just cut, drill, and bolt.
- Mud-sill anchors connect a wooden sill plate to a concrete foundation, eliminating anchor bolts and drilling.
- Wall braces made as flat or formed metal strips are used to diagonally brace a stud wall. They replace traditional 1×4 bracing, which requires cutting notches.
- Staircase angles let you make steps without figuring angles and cutting notches.
- Nail plates are multipurpose con-

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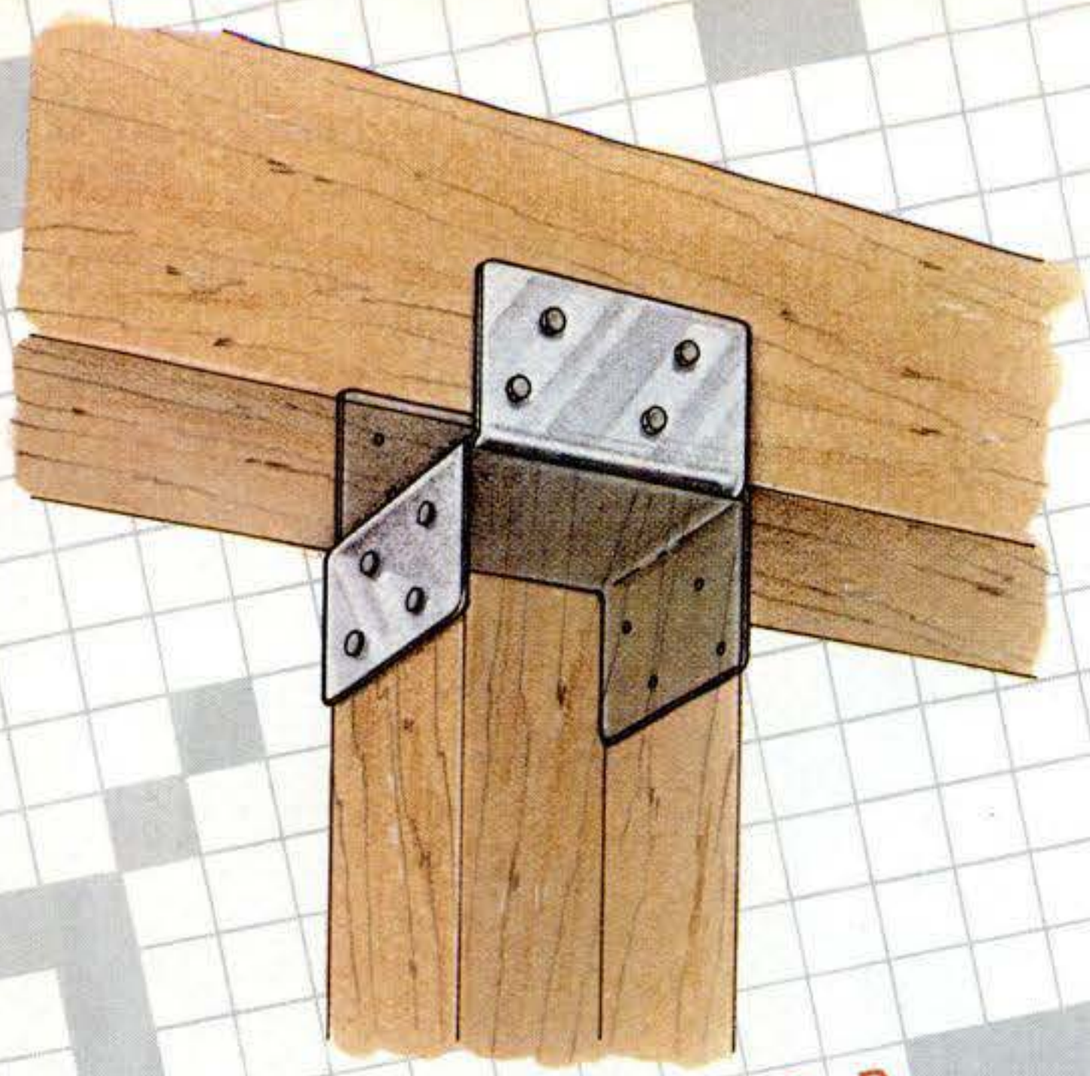
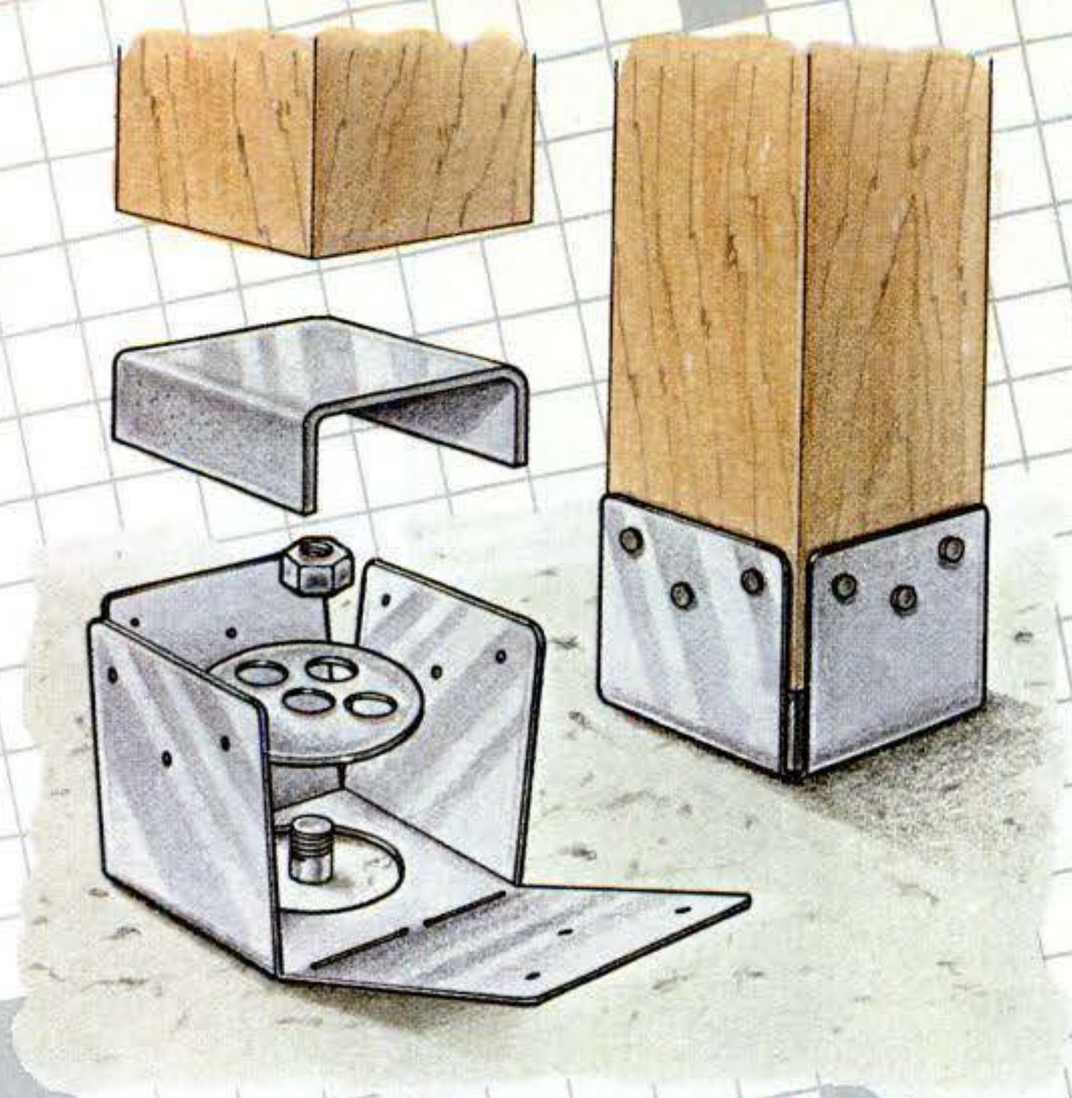
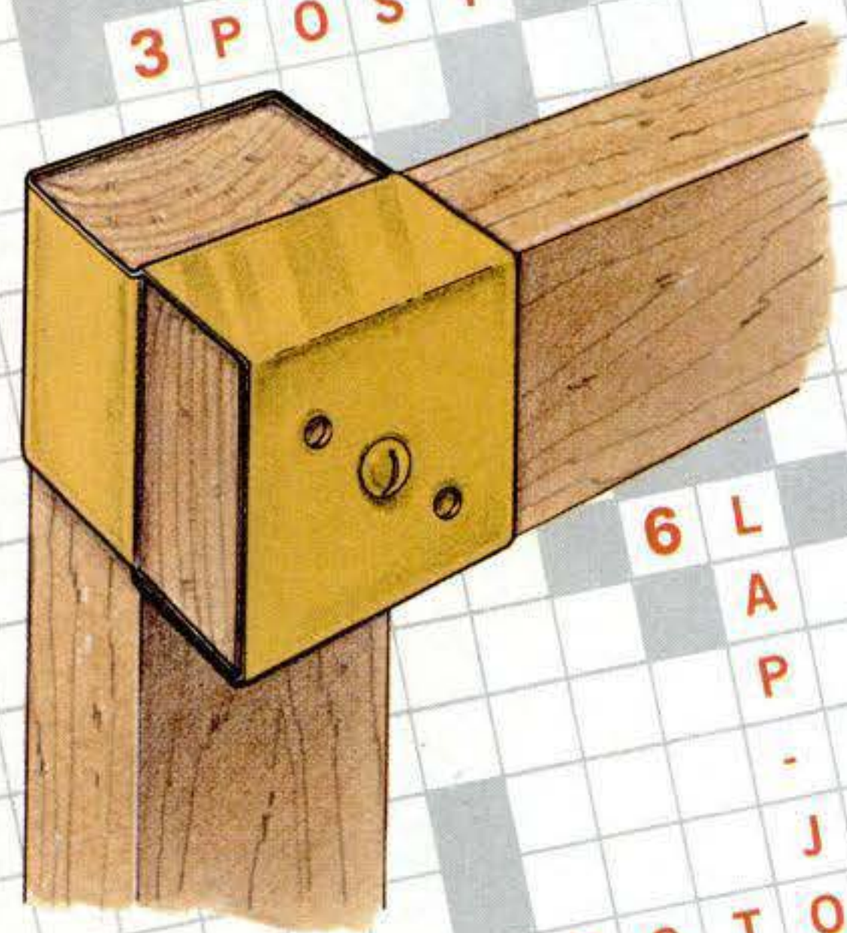


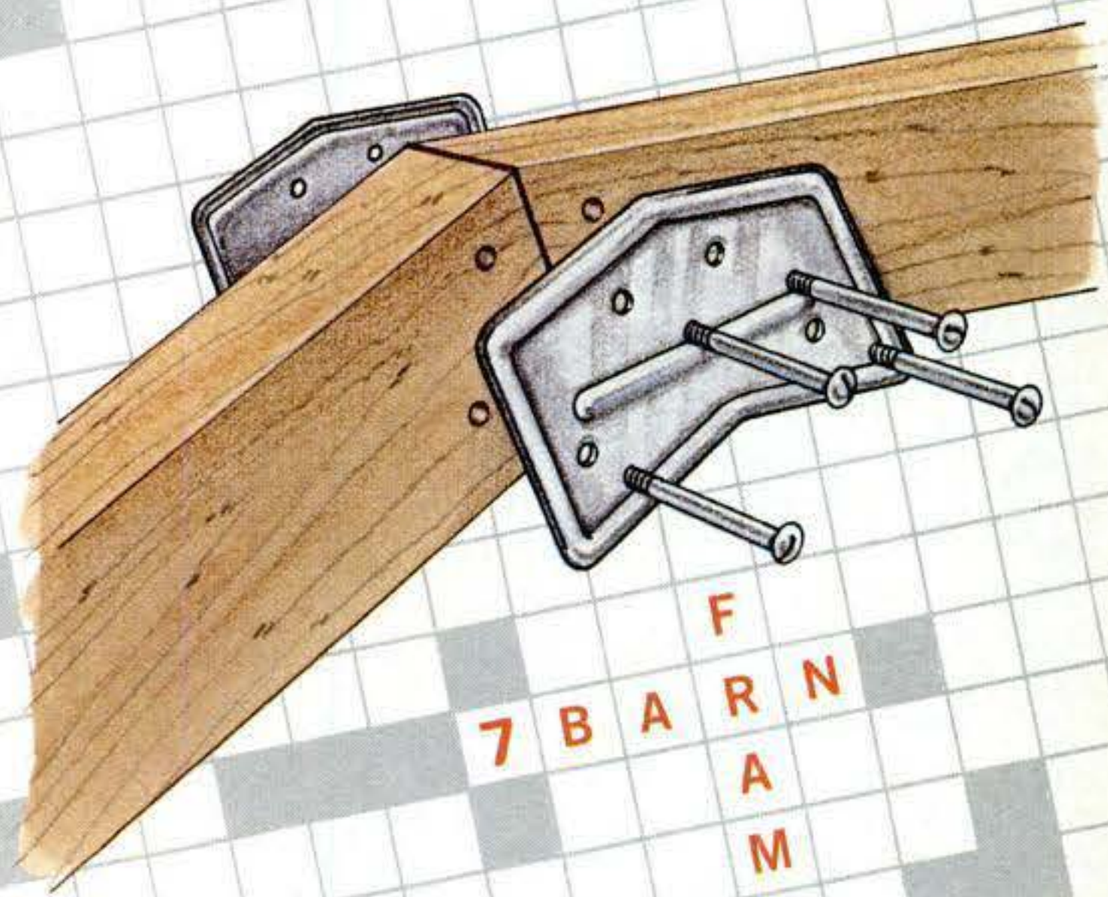
3 POST CAP



4 POST BASE



6 LAP-JOINT CONNECTOR



7 BARN FRAMER

nectors used for splicing, framing, and mending. Some have self-nails; others have nail holes.

- L-angles and T-straps attach to posts and beams for added strength at butt joints.
- Drywall stops are clever little clips that attach to framing wherever you need a stop for drywall. They can eliminate double framing at corners.
- Stud shoes and nail safety plates protect and support through-the-stud piping and wiring.
- Between-joist metal bridges can prevent or cure squeaky floors.
- Hurricane and seismic anchors strengthen trusses and rafters against wind uplift and earthquake damage. They also can be used as ties where one member crosses another.
- Framing clips are used for fast, accurate perpendicular joining of 2×4, 2×6, and 2×8 framing without toe-nailing. They are also ideal for fence construction.
- Fence brackets are nailed to fence posts, then rails are dropped into their U-shaped channels. Rails can be nailed or screwed to the brackets or left free for easy removal.

Follow the makers' specifications for maximum load limits on all carpentry connectors. For fasteners, follow the specs or use the largest-diameter nail, screw, or bolt that the holes will take. PS

SOME MAKERS OF CARPENTRY CONNECTORS

Atlas Engineered Products, 10611 E. 59th St., Indianapolis IN 46236; **Cleveland Steel Specialty Co.,** 14400 S. Industrial Ave., Cleveland OH 44137; **Crawford Products,** 301 Winter St., West Hanover MA 02339; **Fulton Corp.,** 303 Eighth Ave., Fulton IL 61252 (E-Z Builder); **KC Metal Products,** 1960 Hartog Dr., San Jose CA 95131; **Panel Clip Co.,** Box 423, Farmington MI 48024; **The Billy Penn Corp.,** 1831 N. Fifth St., Philadelphia PA 19122; **N. H. Rudeen Co.,** 2721 Nevada Ave. N., Minneapolis MN 55427; **Silver Metal Products,** 2150 Kitty Hawk Rd., Livermore CA 94550-9611; **Simpson Strong-Tie Co.,** Box 1568, San Leandro CA 94577; **Steel and Wire Products Co.,** Box 207, Baltimore MD 21203; **Teco,** 5530 Wisconsin Ave., Chevy Chase MD 20815; **United Steel Products,** Hickory at Fourth St. N.E., Montgomery MN 56069 (Kant-Sag and Starplate)

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Anti-lock brakes for motorcycles

BMW introduces the first anti-lock braking system for production motorcycles. By averting wheel lockup, it provides a vital safety reserve for emergency braking situations.

By STUART F. BROWN

ANAHEIM, CALIF.

Dressed in leather from head to toe, two motorcycle racers strap on their helmets and straddle a pair of BMW bikes. One machine appears to be a standard touring motorcycle; the other is equipped with ungainly hydraulically damped outriggers—the bike tester's version of training wheels.

While the riders motor off to the starting point of their demonstration run, a man with a garden hose is making sure the pavement in this roped-off parking lot is soaking wet. A minute later, the rider on the outrigger bike whooshes into the parking lot at about 40 mph. His right hand clutches firmly at the front-brake lever, while his right foot stabs at the rear-brake pedal. In no time at all the bike skids, completely loses its stability, and pivots crazily around on its outrigger; both rider and machine emerge unharmed.

Now the second rider pilots his stock-looking bike onto the same stretch of glistening pavement. He too hits both brakes with a vengeance. But all this bike does is stop, rapidly and in a straight line—without either tire skidding. The gathering of onlooking reporters releases its collective breath. This has been a convincing demonstration of BMW's new anti-lock braking system (ABS) for motorcycles. Developed by BMW and FAG Kugelfischer, another West German firm that makes hydraulic brake systems, ABS will be offered this fall as a $1,000 option on BMW's top-of-the-line ($8,100–$8,950) K100 series bikes.

The BMW system uses a 100-toothed impulse-generator gear mounted on each wheel (see diagram). Small electromagnetic sensors monitor the gears' passing teeth and send this data to a Hella electronic control unit located in the bike's tail section. When the rate of wheel deceleration under hard braking exceeds a certain threshold, the microprocessor's software determines that wheel lockup is imminent. It responds by commanding a pair of electrohydraulic modulators connected to the front and rear brake circuits to momentarily reduce hydraulic pressure to the brakes as many as seven times per second, averting lockup. The hydraulic pulsing in the BMW motorcycle system, unlike most automotive ABS systems, is isolated by a check valve and can't be felt at the hand or foot controls.

BMW's system can provide "somewhat better" stopping distances on straight dry pavement, at least 12 percent reduction on wet pavement, and as much as 50 percent shorter stopping on changing surfaces, according to product engineer Rudiger Gutsche. This last claim was dramatically borne out at the press introduction when BMW's test riders braked the two bikes hard on a surface of alternating wet-sand patches and wet pavement. The outrigger bike fell over as soon as it hit the sand, while the ABS bike again stayed under control and came quickly and safely to a stop. I watched the ABS bike's tape-marked wheels as this routine was repeated several times, and they never stopped turning for even a moment.

Skill still counts

The ABS systems now available in cars ["BMW Gets Anti-lock Brakes," PS, May '85] give the driver the reassuring ability to maintain steering control during very hard braking. This degree of steering control is not possible in a motorcycle, however, because it must lean over to go around a turn. Gutsche stresses that the ABS system

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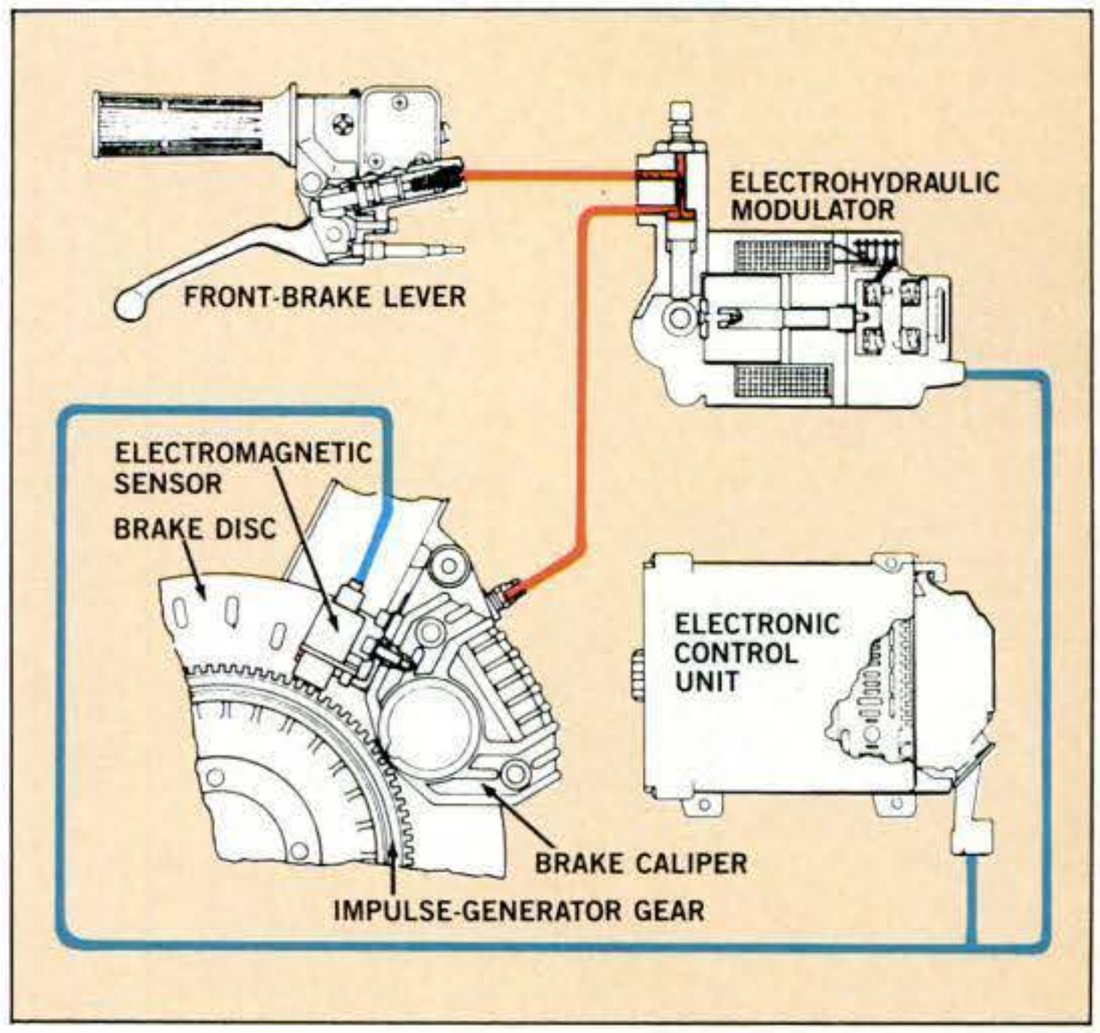
cannot eliminate the motorcycle's tendency to quickly stand up from its inclined position when the brakes are applied hard during cornering, thus losing its lateral stability. "ABS cannot change the physics of the motorcycle. The rider still has to brake carefully in turns," he says.

BMW didn't want to turn the press loose for test rides on its prototype ABS bike, so the closest I could get to a firsthand experience was several minutes spent aboard a static bike mounted on a chassis dynamometer with motor-driven rollers. Flipping the ABS cutoff switch (production bikes won't have this feature), I found that both front and rear wheels locked up readily on the water-doused steel rollers when only moderate braking pressure was applied. With the ABS turned on, performance was as BMW claimed; down to a speed of 2.5 mph—when the system cuts out—neither wheel would lock up, regardless of how hard I hit the brakes.

The combined weight of the ABS system's wheel sensors, hydraulic control units, and computer module is a hefty (for a motorcycle) 22 pounds. But the sensors located at the wheels weigh only about 10 ounces each, so the added unsprung weight has a minimal impact on the suspension system's road-holding ability. The two 8.4-pound linear-motor pressure modulators are located on each side of the motorcycle above the footrests, near the bike's center of gravity.

BMW officials believe ABS is even more important to motorcycle safety than it is to automobile drivers. Motorcyclists, who must be forever wary of the danger of locking a wheel and hitting the pavement, can only agree. After all, you can't fall off a car, can you? PS



The two BMW riders at top are at a test track near Cologne, West Germany. The outrigger-equipped motorcycle on the right has locked up its wheels and lost its stability during hard braking on wet pavement. The ABS-equipped bike next to it remains upright and controllable under the same conditions. Diagram above shows the front brake circuit's major components; a similar circuit serves the rear brake. The electronic control unit is shared by the two brake circuits. Hydraulic lines are red; electrical lines, blue.

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What? You don't own a

One of America's leading experts on the use of power tools in the home shop shows just how versatile a band saw can be. He also makes a strong case that, next to your table or radial-arm saw, a band saw can be your most valuable cutting tool. Finally, he shows you how to build and use a master jig that will greatly increase a band saw's utility.

By R. J. DeCRISTOFORO
Lead photo by Greg Sharko

Shove over, table saw. Look out, jigsaw. Make room for one of the most useful tools in the workshop: the band saw.

A band saw? I questioned their value, too . . . until I tried one. It won't replace my jigsaw or table saw, but for lots of special woodworking jobs, I found that nothing beats a band saw in power, speed, and accuracy. For example:

- Heavy-duty work: Square off the end of a heavy beam or slice through it lengthwise.
- Delicate jobs: Carefully—but quickly—follow the intricate profiles of compound shapes on adjacent sides of heavy stock.
- Repetitive operations: Make identical components in a single pass by resawing a pre-shaped pattern.

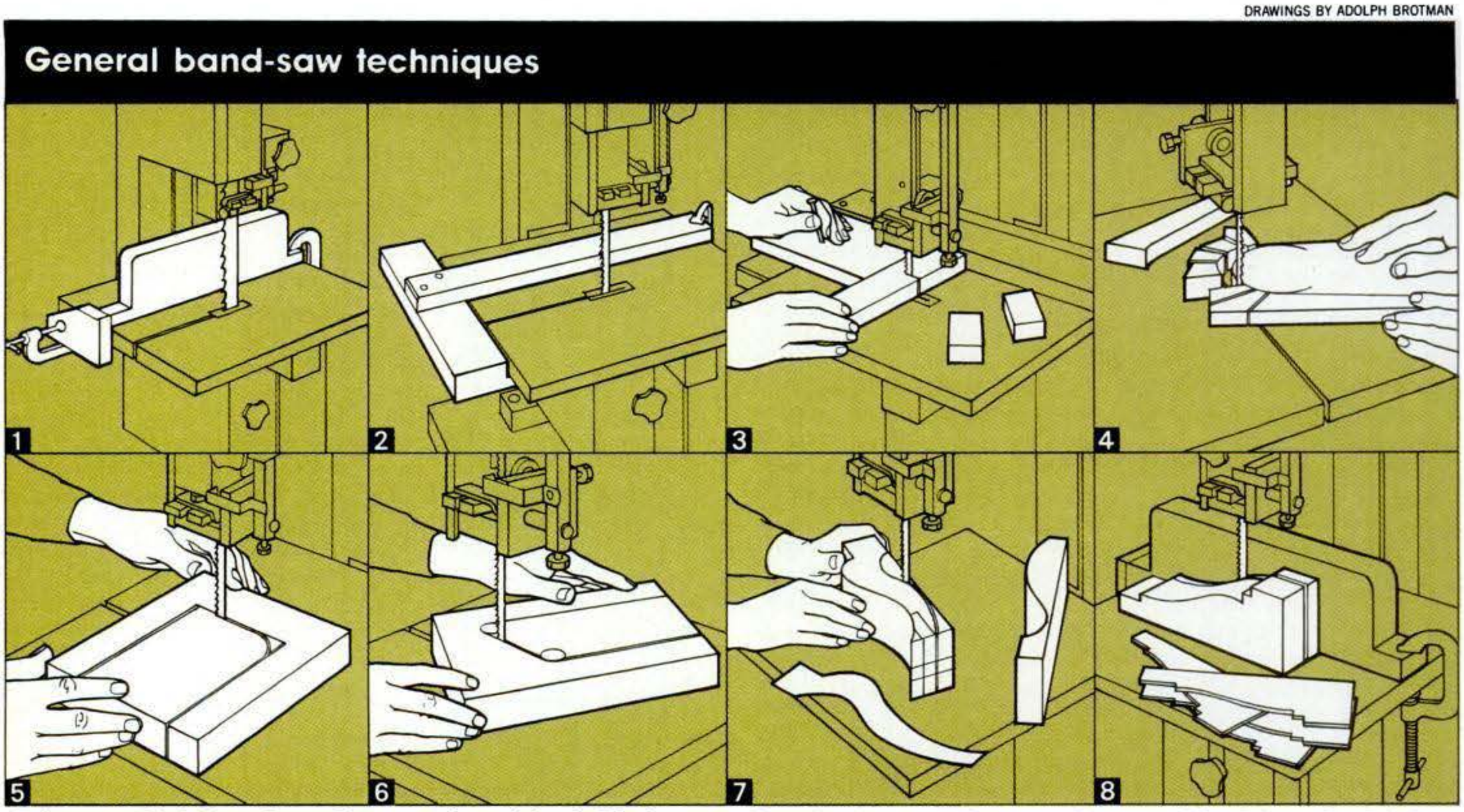
The photos and drawings show you the details of how to make some of these special cuts and more. Then, after adding a master jig (I'll tell you how to make one later), you'll wonder how you got along without a band saw for so long. Here are the basics:

Tricks of the blade

If you think a band saw is a large, cumbersome piece of equipment, you're right. The heavy-duty professional models take up lots of space and will likely require some planning before you fit one in your workshop. (The cords are short, so be prepared to add a high-on-the-wall AC outlet, as well.)

Continued

DRAWINGS BY ADOLPH BROTMAN



1 An extra-high fence keeps large work upright. A shim keeps the kerf open. 2 Use a T-square fence on either side of the blade if the saw lacks a fence. 3 The fence can be used as a stop for making similar pieces. A pusher gets the stock past the blade; a 16d nail becomes a convenient handgrip. 4 Get a wide blade around a small curve by making radial cuts. 5 To make a cutout with square corners, cut the two sides first, back out of the second cut, and lead into the third. 6 Make a cutout with rounded corners by drilling corner holes. 7 Compound sawing is done by drawing the piece's profile on adjacent sides of the stock. After cutting first side, tape waste pieces back in place, then saw through the second side. 8 A pre-shaped block can be sliced into components that are exactly alike.

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band saw?

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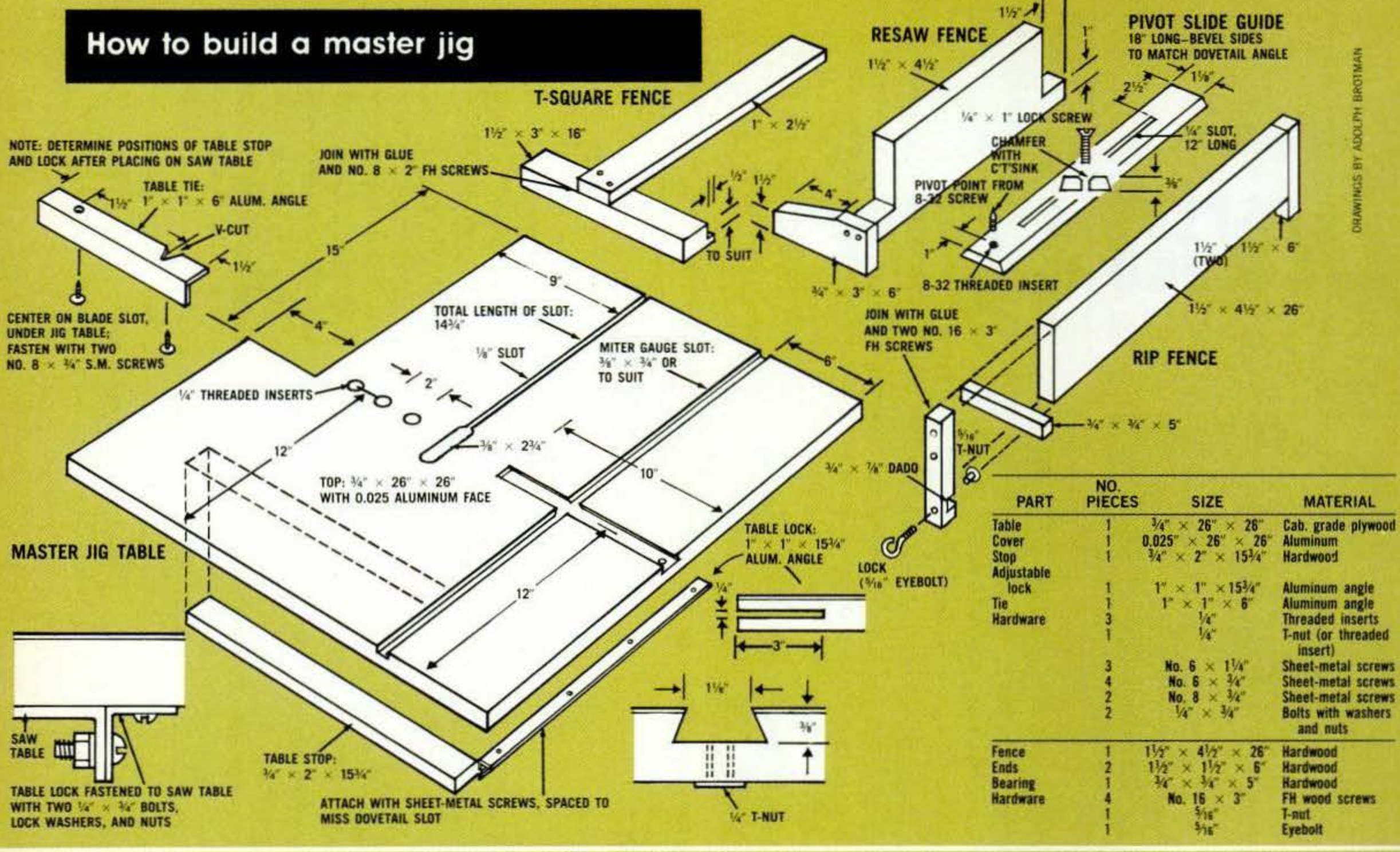
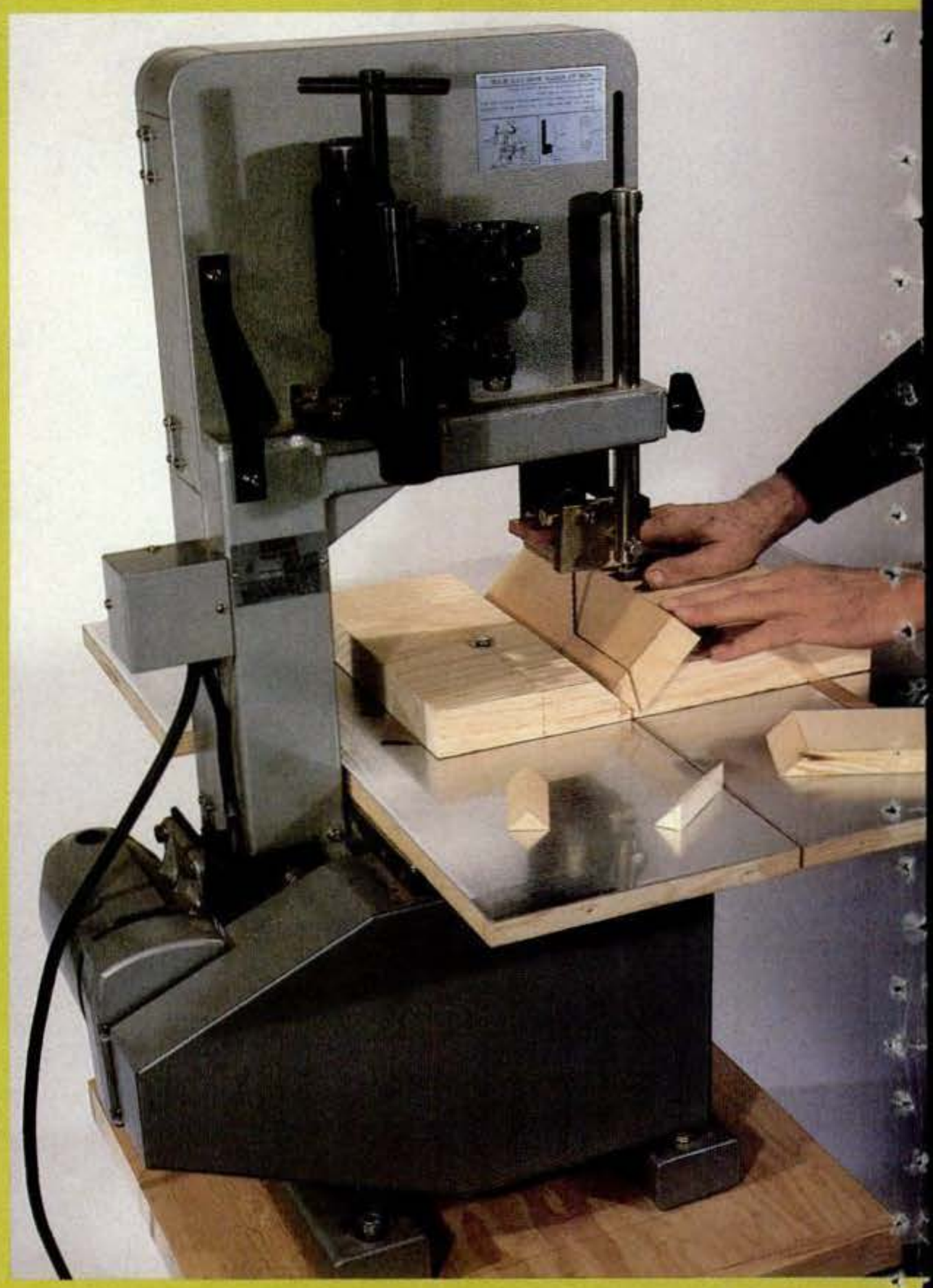
How to build a master jig

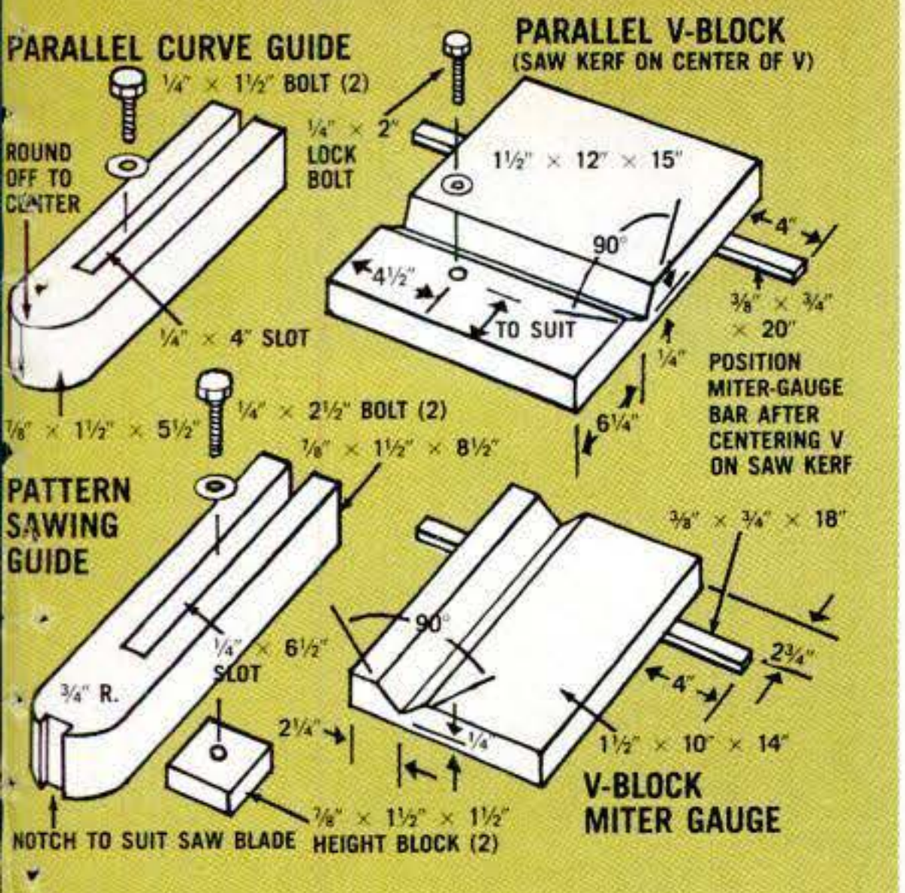


DRAWINGS BY ADOLPH BROTMAN

PART	NO. PIECES	SIZE	MATERIAL
Table	1	¾" × 26" × 26"	Cab. grade plywood
Cover	1	0.025" × 26" × 26"	Aluminum
Stop	1	¾" × 2" × 15¾"	Hardwood
Adjustable lock	1	1" × 1" × 15¾"	Aluminum angle
Tie	1	1" × 1" × 6"	Aluminum angle
Hardware	3	¼"	Threaded inserts
	1	¼"	T-nut (or threaded insert)
	3	No. 6 × 1¼"	Sheet-metal screws
	4	No. 6 × ¾"	Sheet-metal screws
	2	No. 8 × ¾"	Sheet-metal screws
	2	¼" × ¾"	Bolts with washers and nuts
Fence	1	1½" × 4½" × 26"	Hardwood
Ends	2	1½" × 1½" × 6"	Hardwood
Bearing	1	¾" × ¾" × 5"	Hardwood
Hardware	4	No. 16 × 3"	FH wood screws
	1	5/16"	T-nut
	1	5/16"	Eyebolt

How to use a master jig





Pivot slide guide	1	3/8" × 1 1/2" × 18"	Hardwood
Hardware	1	8-32	Threaded insert
	1	1/4" × 1"	FH bolt
	3	8-32 × 1"	Screws (to shape as pivot points)
Pattern sawing guide	1	7/8" × 1 1/2" × 8 1/2"	Hardwood
	2	7/8" × 1 1/2" × 1 1/2"	Hardwood
Hardware	2	1/4" × 2 1/2"	Bolts with washers
Parallel curve guide	1	7/8" × 1 1/2" × 5 1/2"	Hardwood
Hardware	2	1/4" × 1 1/2"	Bolts with washers
Parallel V-block	1	1 1/2" × 12" × 15"	Hardwood
	1	3/8" × 3/4" × 20"	Hardwood
Hardware	1	1/4" × 2"	Bolt with washer
V-block miter gauge	1	1 1/2" × 10" × 14"	Hardwood
	1	3/8" × 3/4" × 18"	Hardwood

For lighter work, there are new compact band saws. These have less horsepower than the pro models and are limited to a cut depth of about four inches (pro models can cut up to 12 inches), but they're relatively inexpensive (about $200 compared with $300 and higher for pro models) and can do the same types of work. Many compacts have built-in speed controls. With variable speed—and the correct blade—they can be used to cut metal, too.

All band saws use a flexible continuous-loop blade that moves in a clockwise direction. The blades are available in a variety of widths from 1/8 to 3/4 inch. The one you use depends on the job.

For example, unlike a table or radial-arm saw, band saws aren't limited to just a few inches of depth when resawing or ripping. And for these jobs wide blades are used. (A narrow blade could bow and produce a curved surface instead of a flat one.)

However, the wider the blade, the fewer the number of teeth per inch—and the rougher the cut. How do you cut big stock and get a smooth cut, too? My trick: Aside from using the smallest blade that will do the job, I lightly hone—dull—both sides of the blade. Honing lowers the cutting speed but because it reduces the set of the teeth, the cut is smoother.

Narrow blades are used for intricate work. For instance, when I made cabriole legs for furniture, only the steady blade of the band saw would do. The usually versatile jigsaw was useless.

The narrower the blade, the tighter the turn it can make. A one-inch circle can be cut by using a 1/8-inch blade. A 3/4-inch blade can't do better than a six-inch circle. But it's not always necessary to change blades for one cut. I start with relief cuts (see drawings) so waste falls away to leave more room for the blade to turn.

Even though the band saw uses a continuous blade, don't discount the tool for inside cuts. For example, I wanted to cut a center section out of a large stock of wood—too large for the jigsaw—without making a lead-in cut. To do it, I first drilled a hole in the wood the width of the blade. Then I cut the blade, routed it through the hole, and welded it back together.

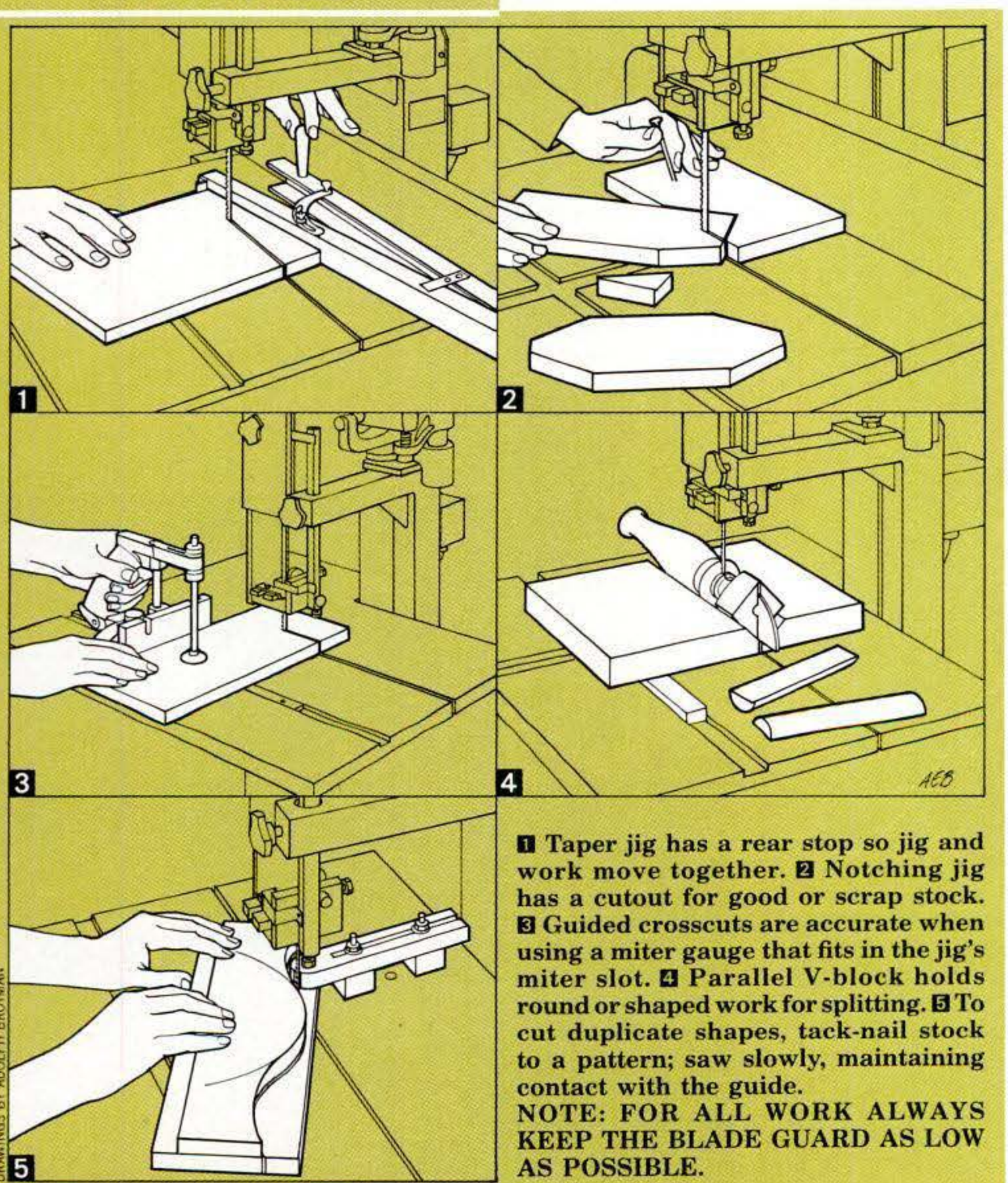
After I made the cut, I broke the blade again and removed the finished stock. Sound extreme? Not really. Blade-welding units are available for this purpose, and blade stock can be bought in hundred-foot coils so you can assemble blades as needed.

Master jig

A master jig increases the table surface and has accessories that allow controlled procedures for most band-saw operations. My jig (see drawings) is made for a nine-inch saw with a 15 3/4-inch-square table. Unless your saw is radically different, you needn't make extreme changes in the design.

Cut the table to size, and attach the aluminum cover (with contact cement) before checking to see what changes might be required. A relief area for the column of the machine is needed so the table can be tilted. Mine is L-shaped because my saw has rear-mounted tension and tracking mechanisms. Otherwise, the relief area can be U-shaped.

When complete, sand all surfaces and apply several coats of sanding sealer, lightly sanding after each coat. Finally, apply paste wax rubbed to a polish on all bearing areas, including the cover, miter-gauge slot, and pivot-guide slot. The result is an accessory that will last a lifetime. PS



DRAWINGS BY ADOLPH BROTMAN

1 Taper jig has a rear stop so jig and work move together. 2 Notching jig has a cutout for good or scrap stock. 3 Guided crosscuts are accurate when using a miter gauge that fits in the jig's miter slot. 4 Parallel V-block holds round or shaped work for splitting. 5 To cut duplicate shapes, tack-nail stock to a pattern; saw slowly, maintaining contact with the guide.

NOTE: FOR ALL WORK ALWAYS KEEP THE BLADE GUARD AS LOW AS POSSIBLE.

MAKERS OF SHOWN BAND SAWS

Inca AG (Switzerland), distributed by Garrett Wade Co., 161 Ave. of the Americas, New York NY 10013; **Ryobi America Corp.,** 1158 Tower Lane, Bensenville IL 60106; **Skil Corp.,** 4801 W. Paterson Ave., Chicago IL 60646

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FAST

Footer Blocks can be used with slab-on-grade houses as well as houses with basements. They support foundation walls for additions to one- or two-story houses.

FOUNDATIONS

You can build a concrete block foundation for a garage, carport, or house addition without casting a footing. Just assemble these interlocking footer blocks, and you're ready to build a wall.

By RICHARD DAY
Photos by Photo Darkroom

Tom Bertch lives in Floodwood, Minn., where the climate limits construction opportunities to a few months a year. When Bertch decided to build a basement addition to his house last year, he didn't want to wait for a cast-in-place concrete footing to cure. Instead, he created the footing from interlocking concrete blocks developed by the Innovative Design Research Division (IDR) of the National Concrete Masonry Assn.

Bertch says that preparing a concrete footing "had always been the worst aspect of any new construction." But with IDR's Footer Block System, Bertch and a few friends laid a footing in less than an hour. Immediately afterward, they began laying blocks for the basement wall.

"At first," Bertch recalls, "Footer Block sounded too good to be true. But it worked out even better than IDR director Jorge Pardo said it would." Heavy rains collapsed the sides of the hole before Bertch completed his project, but the walls were already high enough to protect his work. The same storm buried his neighbor's poured-concrete footing.

The Footer Block System was created by IDR to reduce foundation costs for low- and mid-rise buildings, and to make it easier for home craftsmen to erect their own block walls—from the ground up. You can assemble the footing quickly because there's no need to build formwork or set up access for ready-mix concrete trucks. According to IDR, even an unskilled laborer can construct the mortarless footing in about half the time of a cast-in-place footing. Because no curing is needed, you can start building a wall at once.

Prefabricated footing segments were introduced in Europe after World War II. Norwegian Leka foundation blocks are 6-by-12-by-20-inch units that, like Footer Blocks, interlock without mortar. A similar system was developed in Japan, but its heavy 36-by-12-by-24-inch blocks must be lowered by cranes. Footer Blocks are the first in the U.S., and they meet most standard U.S. building codes. They are lighter than their predecessors, so you can arrange them single-handedly.

Footer Blocks are made from the same concrete mix as ordinary concrete blocks. But they're solid—no hollow cores. There are two kinds of blocks: stretchers and corners. The 4-by-8-by-16-inch stretchers weigh about 24 pounds each and make an eight-inch-thick wall. The 4-by-8-by-20-inch stretchers bear 12-inch-thick walls. Square units are grouped four or nine to a corner. They're also used to support isolated piers.

Because the blocks can interlock in endless configurations and are shorter than their European counterparts, you can plan various layouts. Bertch says it will be simple for him to tie in more footing and expand his addition.

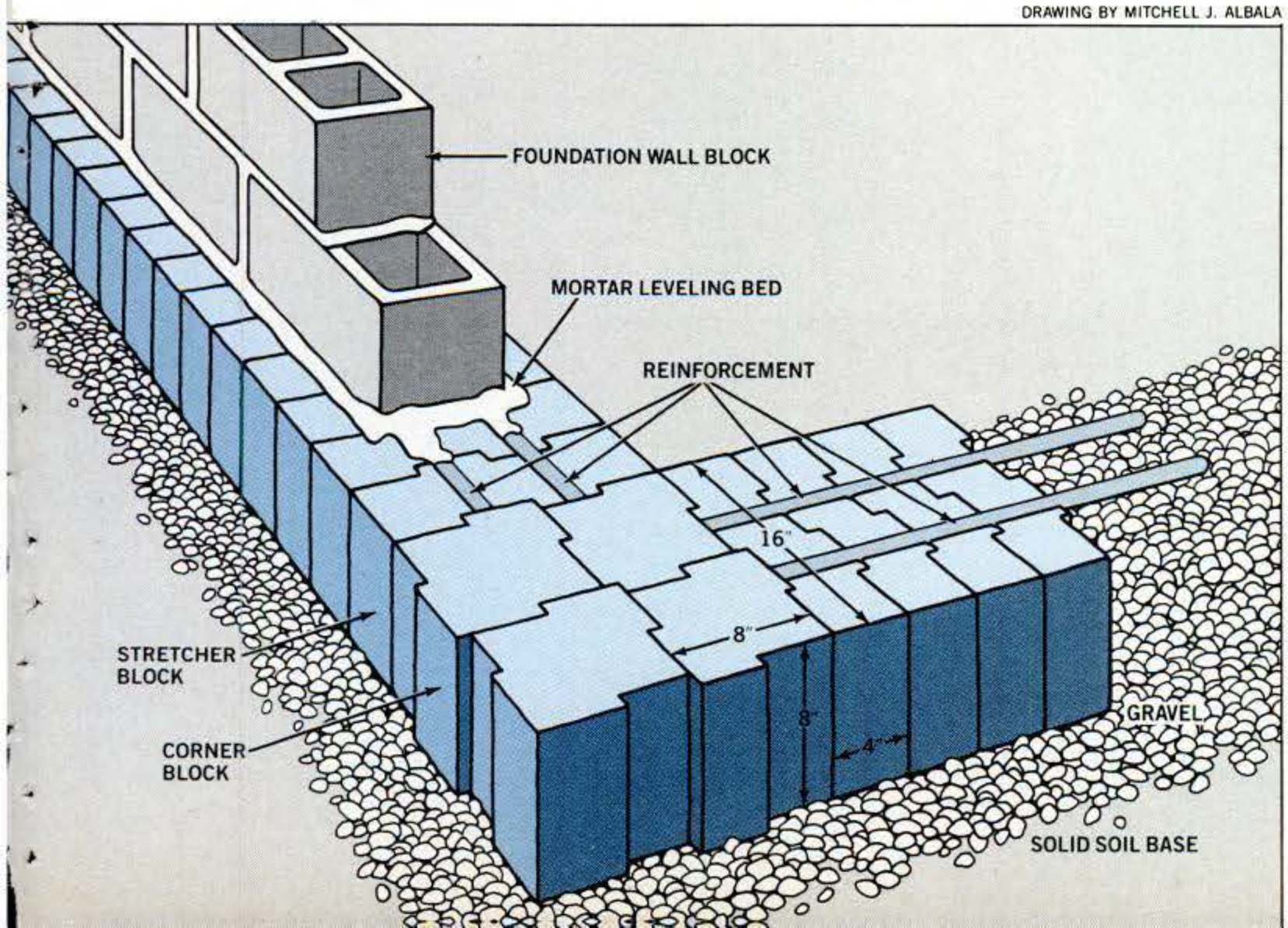
To make a block footing like Bertch's, you'll need to prepare a bare earth base, at least one foot below the frost line. Build on unexcavated earth, not on backfill, mud, or snow. If you wish, you may cover the earth with gravel, mortar, lean-mix concrete, or soil-cement before laying the footing.

Stake out the corner points, and run string lines around the perimeter. Lay blocks along the strings, beginning at the corners, and level the stretchers as you go. Unless you're making a mortarless wall, you can do the final leveling for the first course of block with a mortar bedding.

Grooves in the tops of the stretcher units form key slots. Mortar or grout in the keys helps to resist horizontal forces that might be encountered during backfilling and some earthquakes. You may also place steel reinforcing —"re-bars" or 6-by-3/16-inch trusses— in the keys. In areas subject to earthquakes, you'll have to lay steel re-bars in a course of bond-beam block just above the footing. Steel-reinforced footings and walls are usually built to an engineered design or a building-code-required plan. You may also reinforce walls by pumping core-grouting into the blocks, filling them level with the top of the wall.

The National Concrete Masonry Assn. licenses local concrete block plants to make Footer Blocks. A 16-inch stretcher costs about $1. If you can't find the blocks, contact IDR (Box 781, Herndon, Va. 22070) for the name of the nearest maker. PS

DRAWING BY MITCHELL J. ALBALA



Each Footer Block dovetails with its neighbors, preventing dislocation under lateral loads. Place trusses or re-bars in keys before laying wall blocks.

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TODAY'S CHEVY TRUCKS

Can Chevrolet's newest entry in the compact class compete with the likes of the Tempo, Accord, and Camry?

PS 5,000-mile test
Chevrolet Corsica

By TOM WILKINSON

When POPULAR SCIENCE borrowed a Chevrolet Corsica for a long-term test, we were looking for trouble. We'd been impressed with the samples Chevy had shown at the Corsica-Beretta preview, as well as by a V6-powered Beretta we tested for the February issue. But we were curious. Could we take Chevy's newest prince and turn it into a toad?

We tried. For this test, we asked for an ordinary Corsica with the standard four-cylinder engine, a three-speed automatic, and base suspension and tires. We knew from long experience with Hertz, Avis, and other rental-car companies that domestic compacts so equipped could be slow, noisy, and ill-handling. What about the Corsica? Chevy expects to sell 500,000 a year of its new compacts, the two-door Beretta and four-door Corsica, against competition like the Ford Tempo, Honda Accord, and Toyota Camry. We were worried that the cars might not be up to the task.

The first pleasant surprise came just before Christmas when my wife and I loaded the Corsica with two weeks' luggage and several hundred pounds of photography equipment, then set off across the mountains of Pennsylvania. Most small cars with automatic transmissions react to the long mountain grades on Interstate 80 by constantly hunting between third and second. But the two-liter four had enough torque to pull the heavily loaded Corsica up most hills in top gear, and I could just barely feel the torque-converter clutch gently engaging and disengaging. Engine and road noise were low, although there was some wind rush past the mirrors (a problem Chevy engineers say they're in the process of fixing).

Ride and handling, even with the base suspension and heavy load, proved a good compromise. Broken expansion joints didn't pound us senseless, yet the car was nimble and predictable on twisting mountain two-lanes. The power steering did have a slightly dead feeling on-center. This was a bit disconcerting on rain or ice, as I was never sure when the front tires were starting to skid.

Back in New York, a number of PS staffers spent time with the Corsica. Only two items were consistently criticized: Most drivers found the front seats had too little back support, and almost everyone hated the tiny, hard-to-turn wiper switch. On the other hand, the large trunk, clear instruments, and overall quality were praised.

Other comments reflected personal taste. People used to driving imports felt the ride and handling could have been crisper. The power hungry wished for the optional V6, though the standard five-speed would have made the four-cylinder car both quicker and quieter around town, while preserving fuel economy.

During the 5,000 miles, the car averaged slightly over 27 mpg. The Corsica worked flawlessly, except for a tendency to stumble for a moment or so after a cold start. (Chevy checked the car, but was unable to pinpoint the problem.) Equipped as our test car, with the two-liter four, three-speed automatic, cassette radio, and power windows and locks, the Corsica sells for about $11,900.

No, it's not exciting. But it's not a toad either. And based on the 5,000-mile test, I predict the Corsica will make a lot of Chevy buyers happy. PS

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Make your plans now toward home fire safety

With another heating season behind us, we can reflect anew on the grim statistics of residential fires—most of them caused by defective or improperly used space heaters and wood stoves.

The Insurance Information Institute in New York, N.Y., reports that home fires kill about 4,000 people in the United States each year, and although most of these fatalities occur during the winter, the institute's Barbara Taylor points out that spring is a good time to review fire safety precautions around your house.

Surprisingly, Taylor says, more than 25 percent of U.S. homes still lack smoke detectors, even though these appliances have been readily available for several years and can cost less than $10—and despite the inducement that a number of insurance companies offer discounts on premiums for homes having smoke detectors.

This past winter, Taylor says, many fires were the result of user carelessness, such as putting a kerosene or electric space heater too close to draperies or combustible furniture. "It's important to remember that most home fires start at night, and you really need the warning time you get from a smoke detector," she adds.

A smoke detector should be installed in any hallway leading to bedrooms. Houses with more than one level need at least one detector on each floor. And because most detectors are battery operated, it's not just a case of "install and forget." You need to check the batteries regularly unless your detector is the type that signals when its batteries are failing.

I.I.I. offers a free packet of home fire safety tips. The packet calls for the elimination of potential fire hazards and recommends that you develop and regularly practice a family escape plan. This involves sketching a layout of each floor of your house and marking several practical escape routes, depending on where the fire starts. You should stage frequent fire drills, including some at night after the children have been put to bed, so that all family members are aware that they should assemble at a designated meeting place outside the house.

For a no-cost fire-safety packet, phone 1-800-221-4954.—*Al Lees*

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...and water safety

A short feature in February's POPULAR SCIENCE on installing an under-sink water filter (p. 104) brought this response from Richard Bole of the Watercheck Division of National Testing Laboratories, Inc. (6151 Wilson Mills Rd., Cleveland, Ohio 44143):

"Your readers might like to know that our firm could help them decide whether such filters are necessary in their homes—which would be only after a comprehensive test of their water showed contaminants are present. We provide a single test for 83 contaminants for $89. We send a sampling kit that the homeowner fills with water and returns. The results are in the mail by the third business day. Call us, toll-free, at 1-800-458-3330."

Enclosed with the letter was a brochure announcing that if a Watercheck customer later finds a comparable test analysis at a lower price, the company will reimburse the difference.—*A. L.*

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From crud to crude

Emulsion technology can turn a brick of tarlike hydrocarbons into liquid fuel.

Who says oil and water don't mix? Not Petroferm, Inc. The company claims it's come up with a method for stretching crude oil by mixing bottom-of-the-barrel heavy hydrocarbons with water and a sophisticated emulsifier. It calls the resulting emulsion of 70-percent hydrocarbons and 30-percent water pre-atomized fuel (PAF).

After all of the more valuable products like butane, gasoline, kerosene, and diesel fuel have been boiled out of a barrel of crude oil by various distillation and cracking processes, refiners are left with a thick tarlike substance known as residuum. Utilities and industry normally burn this low-grade hydrocarbon with No. 6 oil or bunker fuel oil. But until recently, this extremely viscous substance had to be first mixed and diluted with expensive, higher-grade No. 2 fuel oil.

Petroferm (Fernandina Beach, Fla.) claims that its residuum-and-water emulsion can be handled and stored like No. 2 fuel oil, but will compete against No. 6 fuel oil. Also, the company maintains that the emulsion burns more cleanly and efficiently than No. 6, with lower nitrous oxide emissions.

Petroferm has recently licensed the PAF technology to Steuart Petroleum Co., a major East Coast marketer and terminal operator of refined petroleum products with annual sales totaling $400 million.

And finally, the same principles that are behind PAF are also being applied in oil fields where emulsions are used to draw extremely viscous heavy crude deposits up from beneath the earth. —*Jack Keebler*

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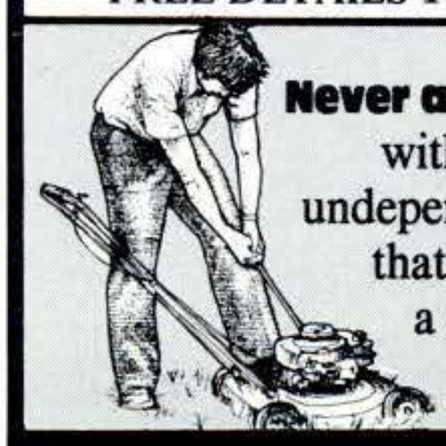

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Multi-task tiller/tractor

In the tractor mode, a spring-tooth harrow rips out old quack grass roots. In the tiller mode (inset), slasher rotors chew into sod to expand a garden.

If you've ever wished you had a power machine that not only tilled your garden, but broke up sod for landscaping, plowed, furrowed, and tore up hard, rocky surfaces, the Merry Tiller System tiller may be just what you need. With a solid-steel 1¼-inch drive shaft, this rugged unit can do all these things—and more.

Rig it as a conventional front-tine tiller, and you can use a variety of rotors for mulching and cultivating, breaking up sod, creating fine seed beds, or aerating your lawn down to four inches deep. Remove the rotors and substitute a speed reducer and two 16-inch bar-lug wheels, and you've got a two-wheel tractor that can pull a plow, harrow, turn-shovel, sweeper, spring-tooth cultivator, or hilling and ridging tool. In winter you can mount a 30-inch blade to plow out your driveway. And most important, all these tools are firmly supported but quickly removed or adjusted with a single pin.

Merry Tillers are available in two-, three-, four-, and five-horsepower models, and are made by Banton Industries (4500 Fifth Ave. S., Birmingham, Ala. 35222). They cost from about $410 for the smallest Mini-Tiller up to $735 for the five-horsepower International model. Keep in mind that you'll have to match the power of your unit to the jobs you'll expect it to do. For example, if you pick, say, the Mini-Tiller, don't expect it to push too much snow.—*E. F. Lindsley*

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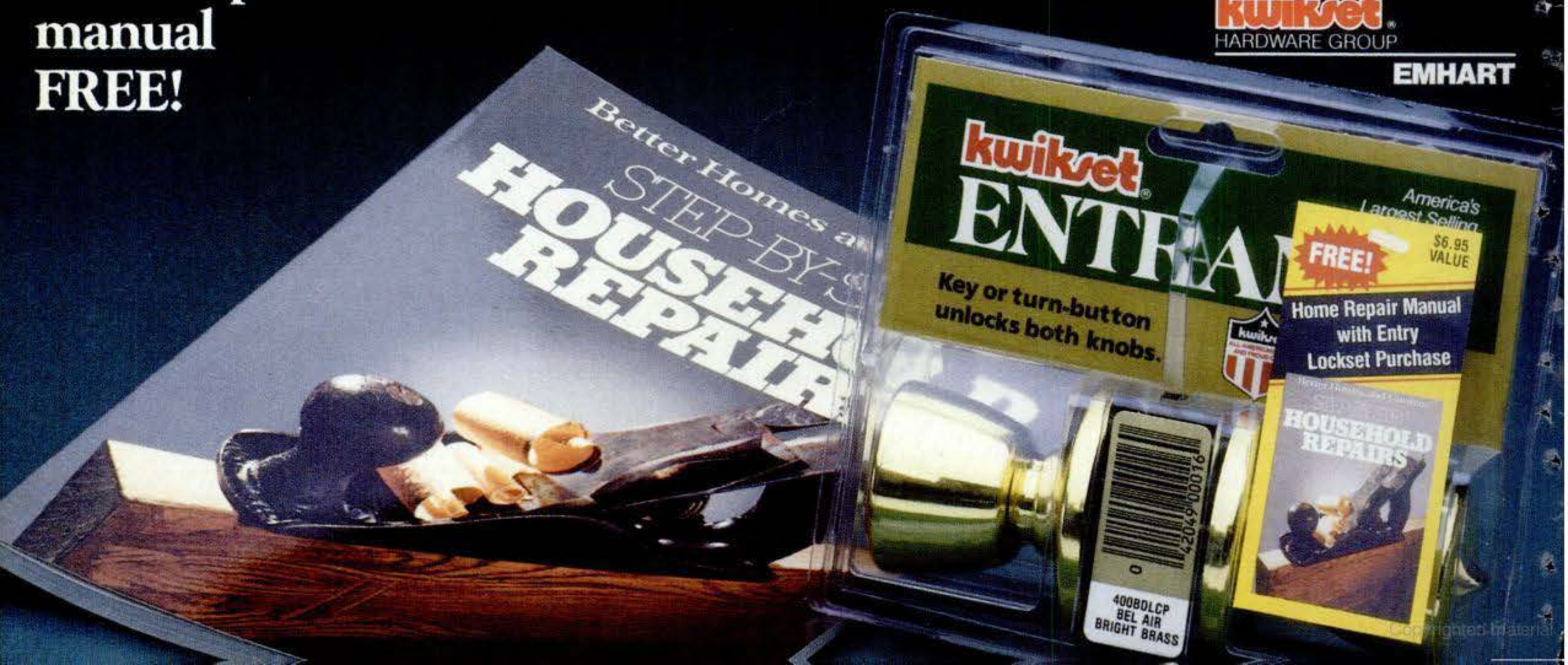

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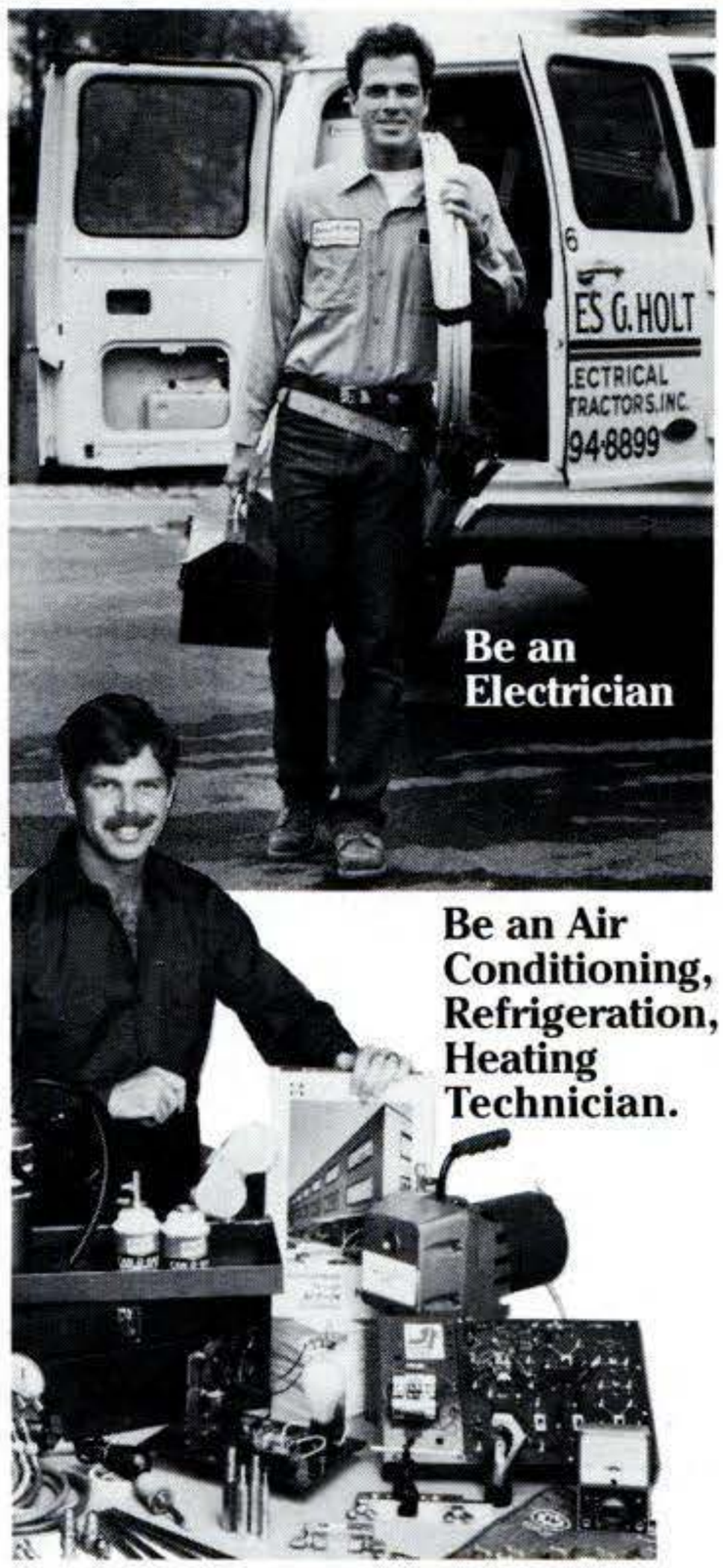

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What's New
PRODUCTS/TECHNOLOGY

BY DAWN STOVER

Water workout

Fitness Fin is designed for safe and efficient exercise in swimming pools. To burn calories, you sweep the molded fin through the water. The paddle, invented by a surgeon, costs $30. AquaGym Fitness Systems Corp., 7647 Bellfort, Suite 7, Houston, Texas 77061.

Toothed ferry

Mud and snow are no problem with this rig. Drive up ramps, jack up the powered wheels of your vehicle, and couple the hubs to shafts. Steer by braking one track at a time. Track Engineering, Fleming Way, Cressex Ind. Estate, High Wycombe, Bucks HP12 3TD, England.

Digital dictionary

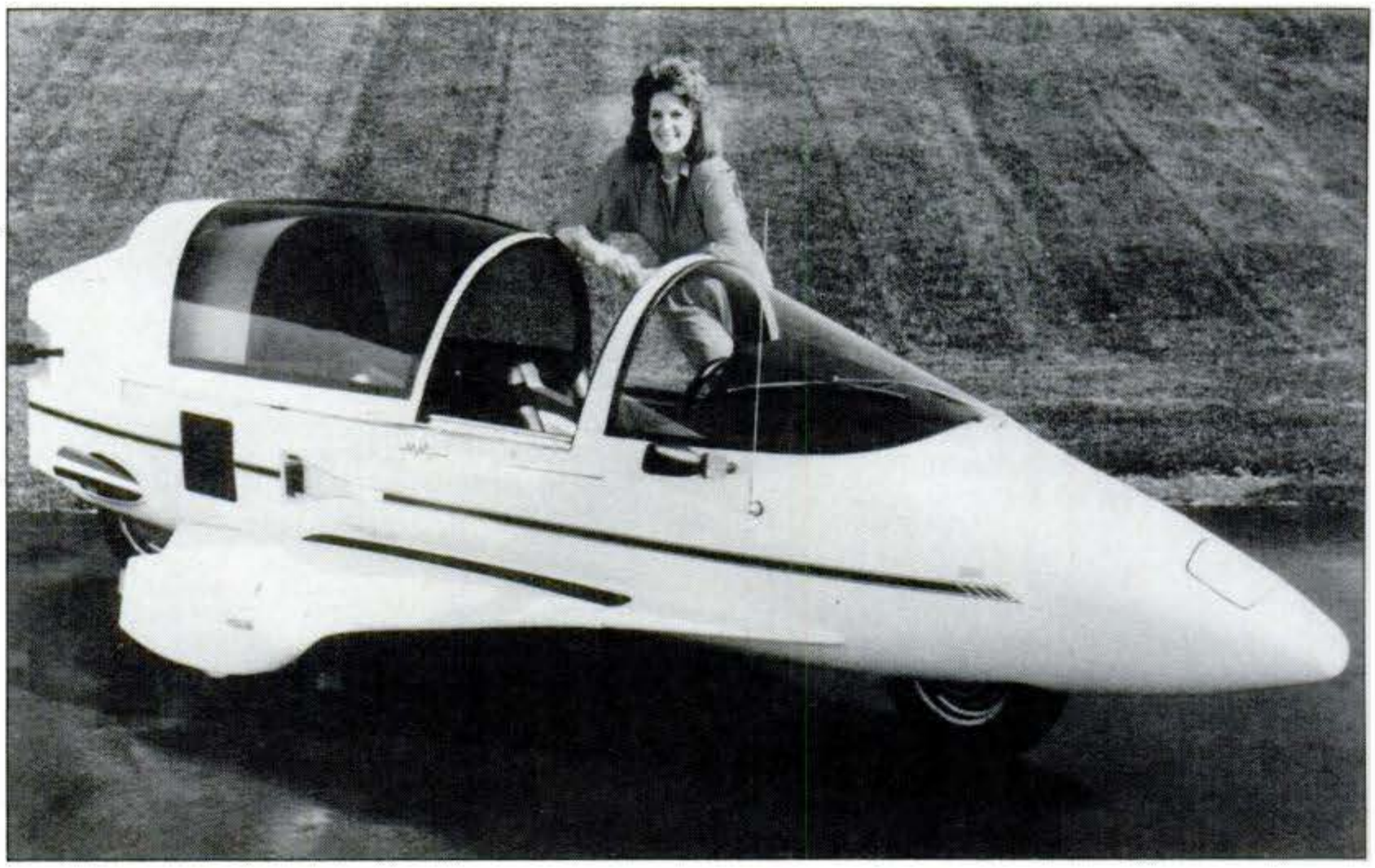
Key-in approximate spellings of up to 88,000 words: The 8-oz. computer offers correctly spelled alternatives. For crossword puzzles, enter letters and blanks, and the checker offers possible words. Hammacher Schlemmer, 147 E. 57th St., New York, N.Y. 10022; $94.50.

Recumbent cycle

Side sticks on the Corsa control steering, braking, and shifting for the nine-speed transmission. Recommended for race tracks and off-road courses, the $895 cycle is capable of speeds over 40 mph, claims H.P.E. Corp. (2030 First Ave., Suite 300, Seattle, Wash. 98121).

Road rocket

The six-speed Pulse GCRV goes over 120 mph, gets more than 70 mpg, and has a drag coefficient of less than 0.02, claims the maker. It seats two beneath a removable acrylic canopy. Pulse GCRV is made by Owosso Motor Car Co., Box 308, Owosso, Mich. 48867. Price: from $11,500.



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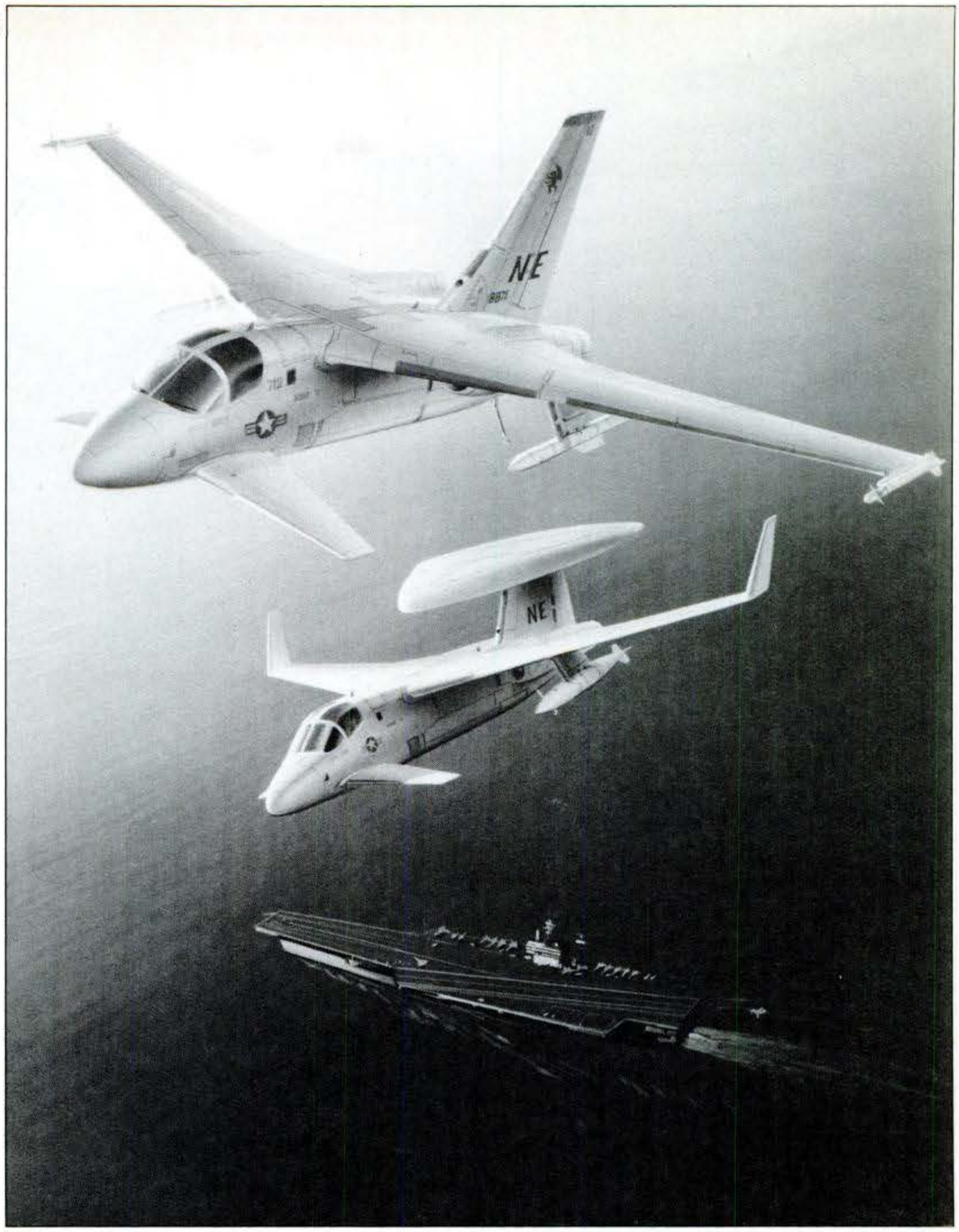
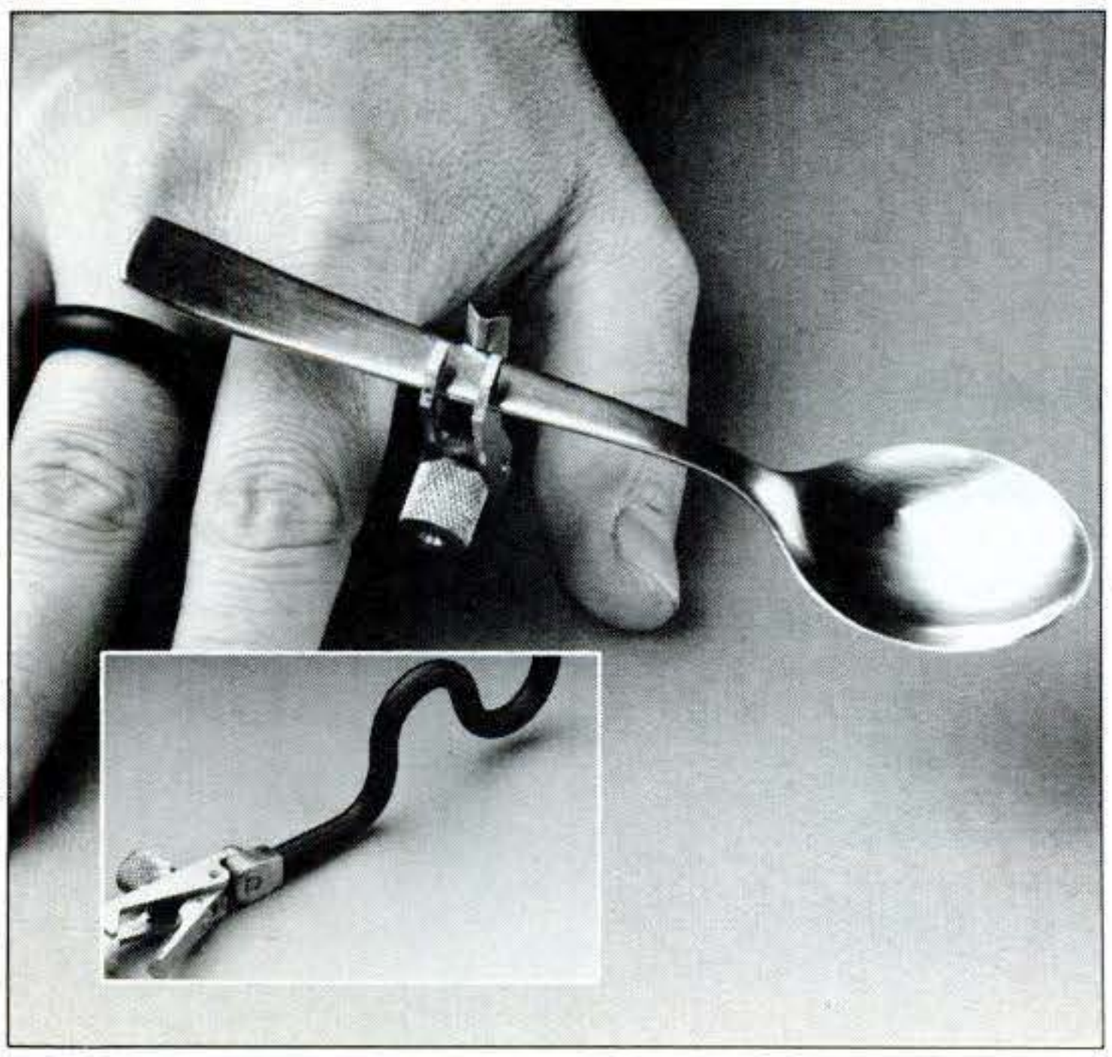
Versatile plane

Lockheed-California Co.'s concept for a carrier-based Navy aircraft is shown performing two roles: anti-surface warfare (top) and airborne early warning (using a radome). Mission-specific sensors would be added to a common core of avionics for various operations.



Down, periscope

Stay dry while you examine a boat's hull, propellers, and struts with this immersible tubular scope. The 1½-in.-dia. 5½-ft.-long scope focuses from 4 in. to infinity, using 1× optics. From Edmund Scientific Co., 101 E. Gloucester Pike, Barrington, N.J. 08007; $150.



Helping hand

Universal Gripper's 180° pivoting head holds toothbrushes, pens, combs, and poker hands. Designed for the handicapped and made of rigid plastic or stainless steel, the gripper can't fall off. IEOD Engineering Ltd., 19, Shimo'n Hatsadik St., Jaffa, Israel.

Exclusive sedan

The handcrafted Bentley Eight, recently introduced in the U.S., is aimed at younger affluent drivers. Behind the mesh sports grille is a 6.75-L fuel-injection V8 engine. The $89,900 car also has ventilated disc brakes, alloy wheels, and a firmly tuned suspension.

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What's New in Photography

BY ARTHUR FISHER

Superfast lens

Part of the extensive line of lenses for Canon's new autofocus single-lens-reflex cameras ["EOS: Fast, Quiet Auto SLR," PS, April], this EF 50-mm is amazingly fast, with an aperture of f/1.0! It also uses a super-quiet ultrasonic motor. The price has not yet been set.

Still video system

This prototype still video camera, the Konica SV-C40, uses floppy disks to record either 25 or 50 images. The image sensor is a tiny charge-coupled device that holds 300,000 pixels. The autofocus camera is designed to work with a recorder/player and a color printer.

Autofocus SLR

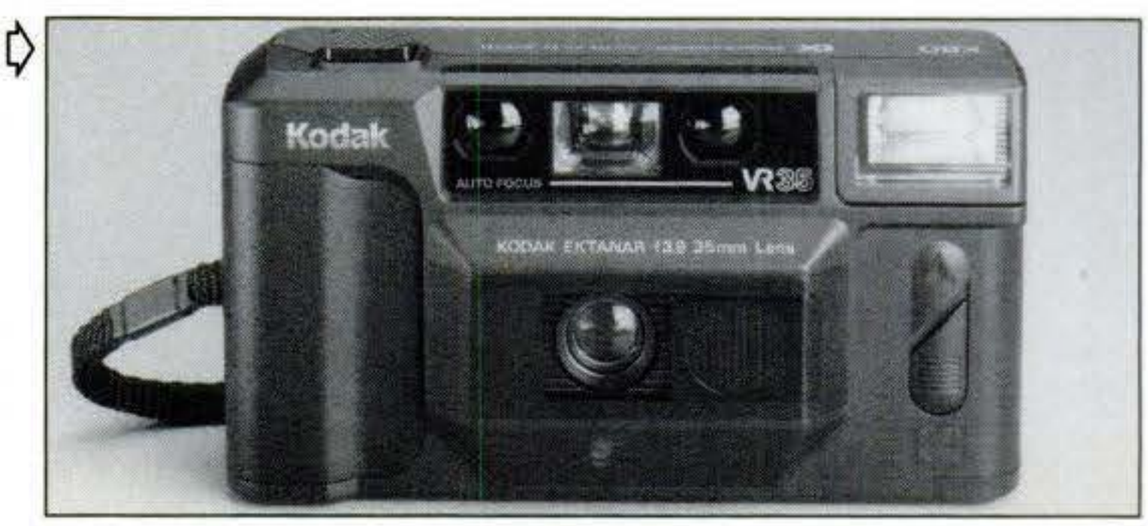
Joining the autofocus single-lens-reflex group—five brands at last count—is this Yashica 230AF. One interesting innovation: a "trap focus" mode that automatically trips the shutter when the subject enters a prefocus zone. Price for the camera body only is $550.

Heavenly drive

You can get started photographing the heavens with this simple motorized camera drive, a hinge-type that is suitable for lenses up to 135-mm. It's available in kit form for $99—or completed for $124—from Astro Kits, 824 Bronx River Rd., Bronxville, N.Y. 10708.

Compact auto 35

Kodak's latest addition to its autofocus line is the VR 35 K80, with the now-usual automatic features: focus, exposure, film advance and rewind, and film-speed setting with DX film. It has a pop-up flash and is powered by two AA batteries. With 35-mm f/3.9 lens: $130.



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What's New for Your Car

BY JACK KEEBLER

Portable phone

The Audiovox CMT-450 cellular phone ($1,495) features a 2-lb. 10-oz. transceiver not much bigger than a video cassette. It has hands-free operation, electronically coded lock, call timer, and a 30-number memory. Its low weight allows mounting with Velcro fasteners.

Belt relief

The tug of a shoulder belt can be irritating. Belt-Eze spreads the belt tension evenly across the shoulder to reduce the chance of soreness or wrinkled clothing, claims the maker. It comes in six colors. Belt-Eze, Box 12465, Fort Worth, Texas 76121. Price: $10.

Fine tools

Sears is introducing a premium line of Craftsman combination wrenches, ratchets, extension bars, and sockets. The wrenches and ratchets feature handle inserts for comfort, thinner profiles to fit in tight spots, and stainless-steel construction for corrosion protection.

Aero cap

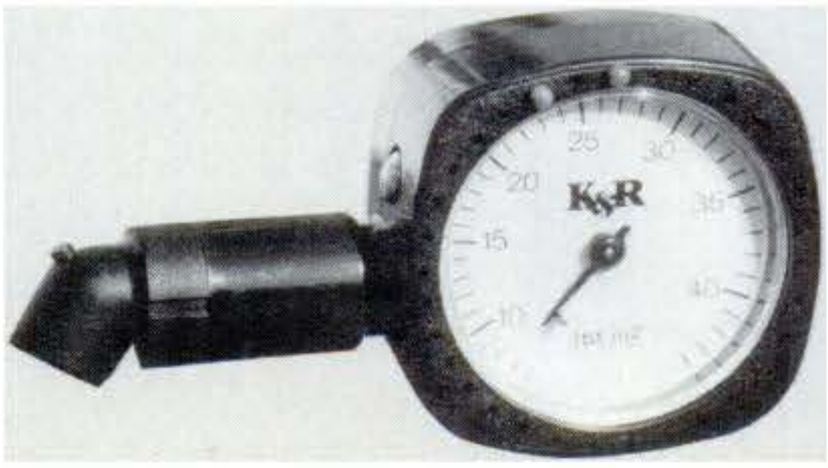
Designed to fit snugly against the cab and bed of specific pickup models, this cap features tip-out side windows, an integrated high-mount brake light, and a smooth paraffin-coated interior. U.S.A. Composites, 207 Bugeye Sq., Barstow, Md. 20610. Price: $889.

Snooze alert

Mount Doze-Alert on a vehicle's steering-wheel rim, and switch on the battery power. Then drive, resting your finger on the alert's trigger button. If you nod off and release the button, the alarm sounds. It costs $22. J. R. Wiggins Co., Dept PS, Box 45, Westville, N.J. 08093.

Clever gauge

This gauge eliminates the need to recheck the manual for correct front and rear tire pressures. Green and red pegs plugged into holes around the gauge's face indicate a vehicle's pressures. Kenrick Enterprises, 255 Oakdale Rd., Nottingham NG4 1BP, England.



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Here's How Patented Tufoil Technology, using PTFE increases engine life . . . does much more!

How? By dramatically reducing your engine's internal friction and operating temperature. Now you can get much longer life from your car's engine *and* save hundreds on gas. Many Tufoil customers are reporting astonishing performance results!

JUST WHAT IS TUFOIL? AND HOW DOES IT WORK?

TUFOIL is an exacting formula of synthetic and mineral oils—combined with friction modifiers and particles of PTFE—the slipperiest substance known to man. Commonly called Teflon or Fluon, its particles are so small they'll pass right through your oil filter—to form a protective coating over all your engine parts. TUFOIL will mix with, and improve the performance of any motor oil you are presently using, cutting friction to the lowest level of any known lubricant! The U.S. National Bureau of Standards tested TUFOIL on their 4-ball tester and found it has a surface friction of .029. The published value for Teflon is .04 so TUFOIL is testing slipperier than Teflon!

Tufoil® technology works . . . here's more proof!

When POPULAR MECHANICS tested TufOIL, it reported gas savings of 10.3%. And they wrote: TufOIL is "absolutely spectacular...There are lots of slick oils on the market, but we've found one that does what it promises."

Home Mechanix says, "One PTFE additive, TUFOIL, has undergone field tests and has scientific evidence backing its claims for easier cold weather starting and improved lubrication and fuel economy. Others do not."

Tufoil turns your motor oil into a super lubricant, protecting all internal engine parts.

HERE'S PROOF! . . .that Tufoil® is better than other lubricants. . .the list keeps growing.

1. Read text for the National Bureau of Standards data.
2. Six U.S. and a number of foreign patents have been awarded to Fluoramics for Tufoil*. More are pending.
3. Independent laboratory tests throughout the country and throughout the world have proven Tufoil's claims of making your car's engine run better, smoother, cooler.
4. In Canada, government tests show a big improvement in low temperature starting for gas and diesel engines with Tufoil* (5% fuel savings)
5. In Australia, researchers at the University of New South Wales reported fuel savings of up to 7%.
6. In Israel, scientists at the Technion Research Institute found Tufoil* a reliable lubricant for scorching desert driving. Save fuel too (4%).
7. In Texas, stationary engines used to pump natural gas are lasting more than twice as long and running cooler on hot sunny days when Tufoil* is used.
8. In New York State, the maintenance engineer at a major automobile manufacturer reports in-plant propane fueled lift trucks' engine life is doubled when Tufoil* is used.
9. More and more police departments and racing drivers are switching to Tufoil* to save engine wear and fuel for faster friction-less starts
10. We've had many customers tell us Tufoil* gives astonishing improvements to their engines. Over the life of your car, this translates into thousands of dollars saved and tens of thousands of extra miles added.

Most engine wear and damage occurs during starting. This is where Tufoil makes a gigantic difference.

Driving causes only a small percentage of the wear on your car's engine; much occurs during starting—that crucial "oil-less" period before your oil has circulated sufficiently to work. With Tufoil, internal engine parts are protected even while the rest of your car's oil is still settled down in the sump.

Tufoil protects your engine best. It's the most sophisticated engine lubricant ever developed for your car.

You'll feel your car respond better, start quicker, accelerate faster, climb grades more easily, idle smoother . . . and you'll notice the results the first time you use it. Tufoil is the next best thing to engine insurance!

In any weather, throughout their entire performance range, engines with Tufoil run easier.

Tufoil's remarkable friction reducing formula will keep your engine temperature lower to prevent overheating.

Hot weather . . . when you shut your engine down on a hot summer day, particularly after a turnpike run, it's often hard to start. Hot parts expand and pinch together. TUFOIL's super low friction helps you get going easier. **Cold weather** puts a big strain on your battery and starting motor. Recent Canadian government and independent lab tests in Michigan verify improvements when TUFOIL is used. Cranking speed for gas engines improved 6.1% . . . diesels 9.6% . . . and a 5% fuel savings too. Six U.S. patents so far! Make winter and summer driving easier.

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What's New in Electronics

BY WILLIAM J. HAWKINS

Super small

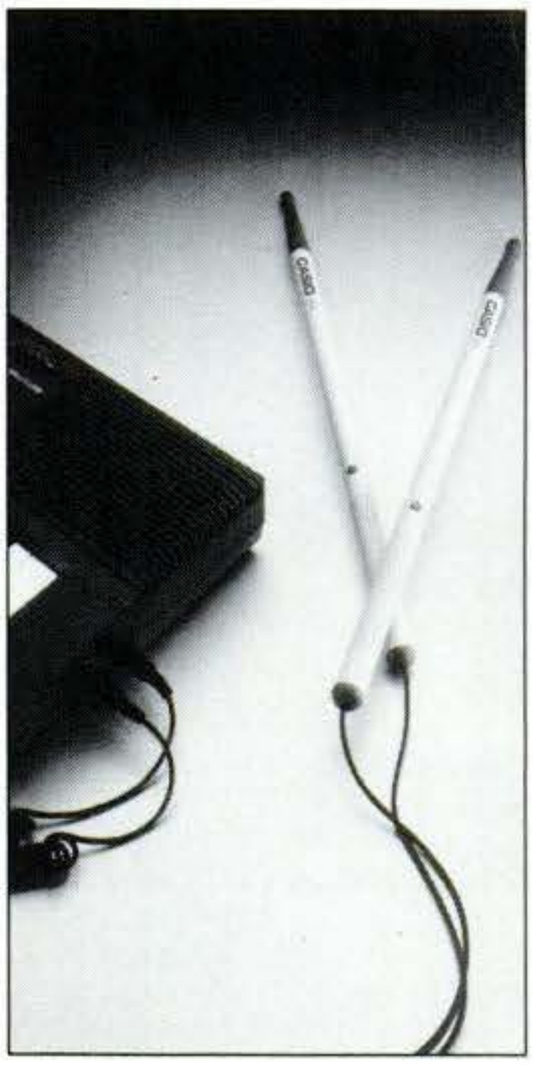
The battery becomes the handgrip on JVC's VHS-C record-only camcorder. Reason: to conserve weight and size. According to the company, the VideoMovie is the lightest and smallest unit made—only 2.2 lbs. with battery and cassette. The price of the camcorder is $1,150.

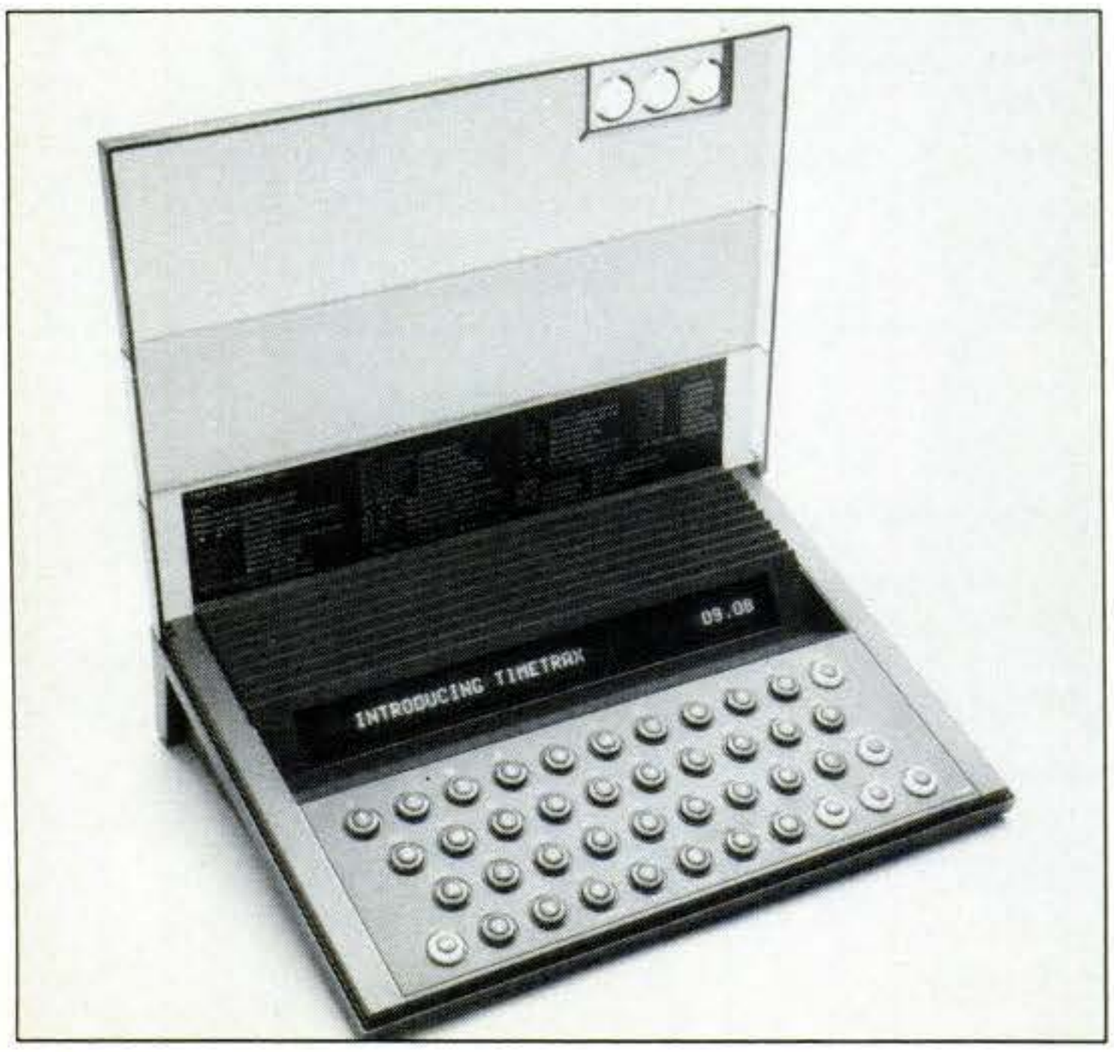
Play it again

Use the Instant Replay calculator just as you would any other. But if you're not sure of an entry, press a button: The clever calc displays up to 32 previous entries for checking. The compact desktop unit is made by Technico, 989 Ave. of the Americas, New York, N.Y. 10018. $13.

Electronic drumsticks

Electronic drumsticks? Connected to one of Casio's selected synthesizer models, the sticks are used—and sound—like normal ones to simulate four drum sounds. The difference: They don't need a drum. Price: $100.





Memory manager

Store up to 200 addresses, 400 phone numbers, seven schedules, and 300 reminders in TimeTrax—the electronic memo pad remembers them all for instant retrieval. Made by Message Technology, Grangewood, Longcross Rd., Longcross, Surrey KT16 0DP, England. $395.

Pocket A-V

It's an audio-video system for your pocket. Sharp's portable has an AM-FM radio, cassette tape player, and LCD TV. Don't look for it in stores, though: It's a prototype and won't be available for some time, according to the manufacturer.

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Make your home into something special!

That's exactly what your home will be when you fill it with Heathkit electronic products – products that make your life easier and more enjoyable. Within our diverse line are kit and assembled products sure to enhance each room in your home.

1. Make your entryway more secure and easy to use with the Keyless Doorlock. You'll never again be locked out because of lost or forgotten keys. All it takes is a simple fingertip entry of a four-digit code, and the Keyless Doorlock unlocks your door.

2. Add a new dimension to your living room with your own Computerized Weather Station. This Digital Weather Station displays up-to-the-minute temperature, wind, and barometric pressure readings, along with time and date.

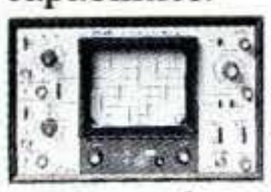
3. Give your kitchen a unique blend of style and efficiency with our Digital Wall Clock. This easy-to-build kit keeps time with quartz-crystal accuracy. And with its simulated oak wood-grain finish cabinet, you'll have a timepiece that fits into almost any decor.

4. Put your den to greater use with this IBM PC AT Compatible Computer. Do word processing, personal accounting and more when you run exciting IBM-compatible software on your fast and powerful HS-241. And you can build it yourself in just a few hours.

5. Bring the latest in digital technology to your bathroom. This Digital Scale lets you closely monitor your weight with electronic precision. And, it's battery operated so it's safe to use right out of the shower.

6. Add a video entertainment center to your bedroom. Our 19"-diagonal stereo TV kit gives you an extra-sharp color-corrected picture with full stereo sound, and convenient viewing that you can control from your bed. Comes in a simulated walnut cabinet that complements your room.

7. Transform your rec room into a haven for hobby fun. Put our Deluxe QRP CW Transceiver in this room and enjoy superb HAM radio operation that excells in performance and features. It offers expandable transmission and reception capabilities.

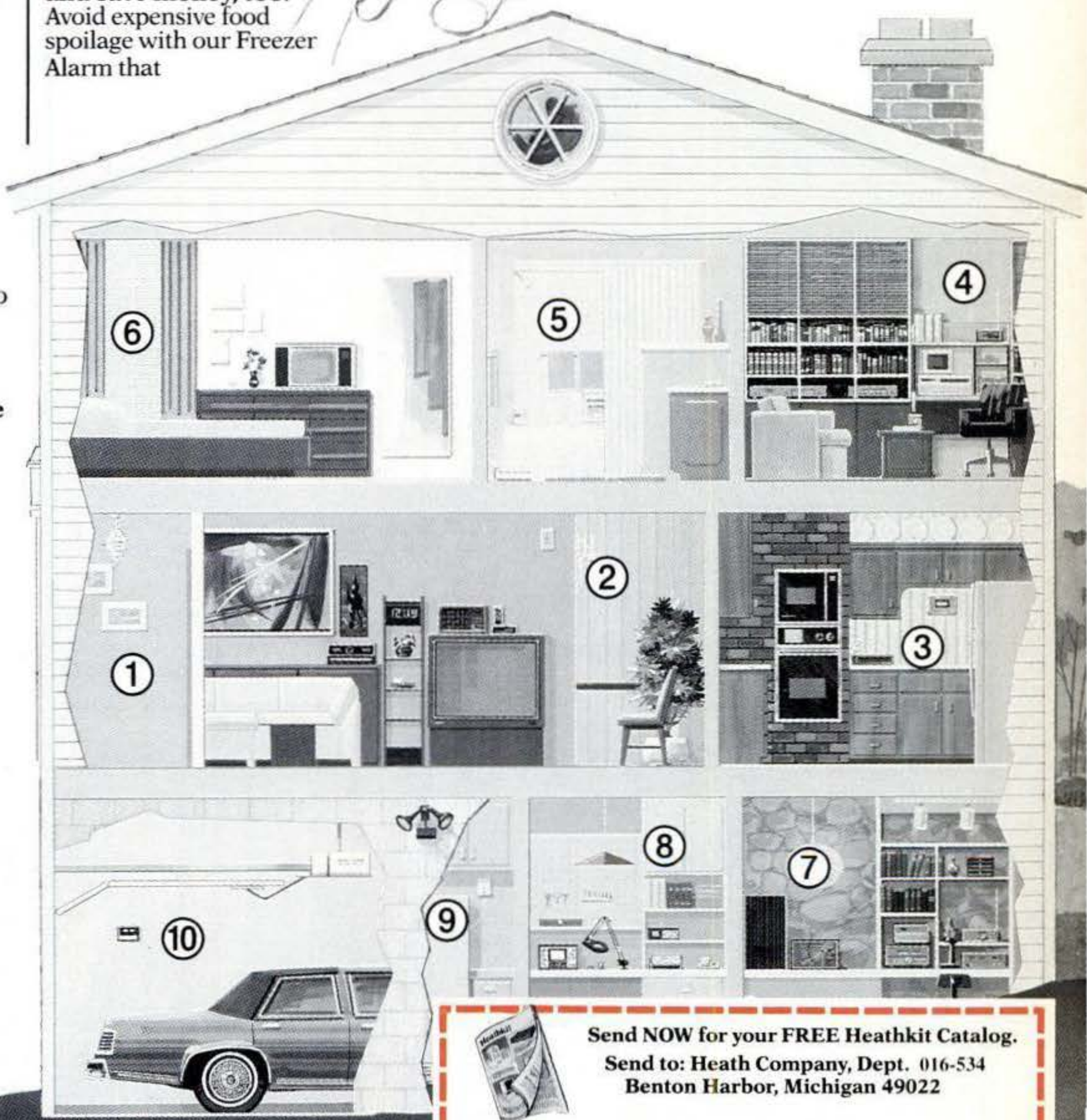


8. Give your workbench a touch of professionalism with this oscilloscope. Whether you're a service technician or a hobbyist, you'll love the wide range of measurement capability our laboratory-grade Dual Trace 10 MHz Oscilloscope gives you.

9. Add practicality to the utility room and save money, too. Avoid expensive food spoilage with our Freezer Alarm that warns you when the inside temperature of your freezer rises too high. Prevent water damage with our Food Alarm that warns you of water that's where it shouldn't be.

10. Make your coming and going easier than ever. Your garage door will open with incredible ease and dependability with our Deluxe Garage Door Opener. Easy to install, this opener is durable and includes a handy security light.

You'll find fun and excitement with every Heathkit product. Whether they're in kit form or already assembled, our products will help you enjoy your home more than you ever dreamed possible.



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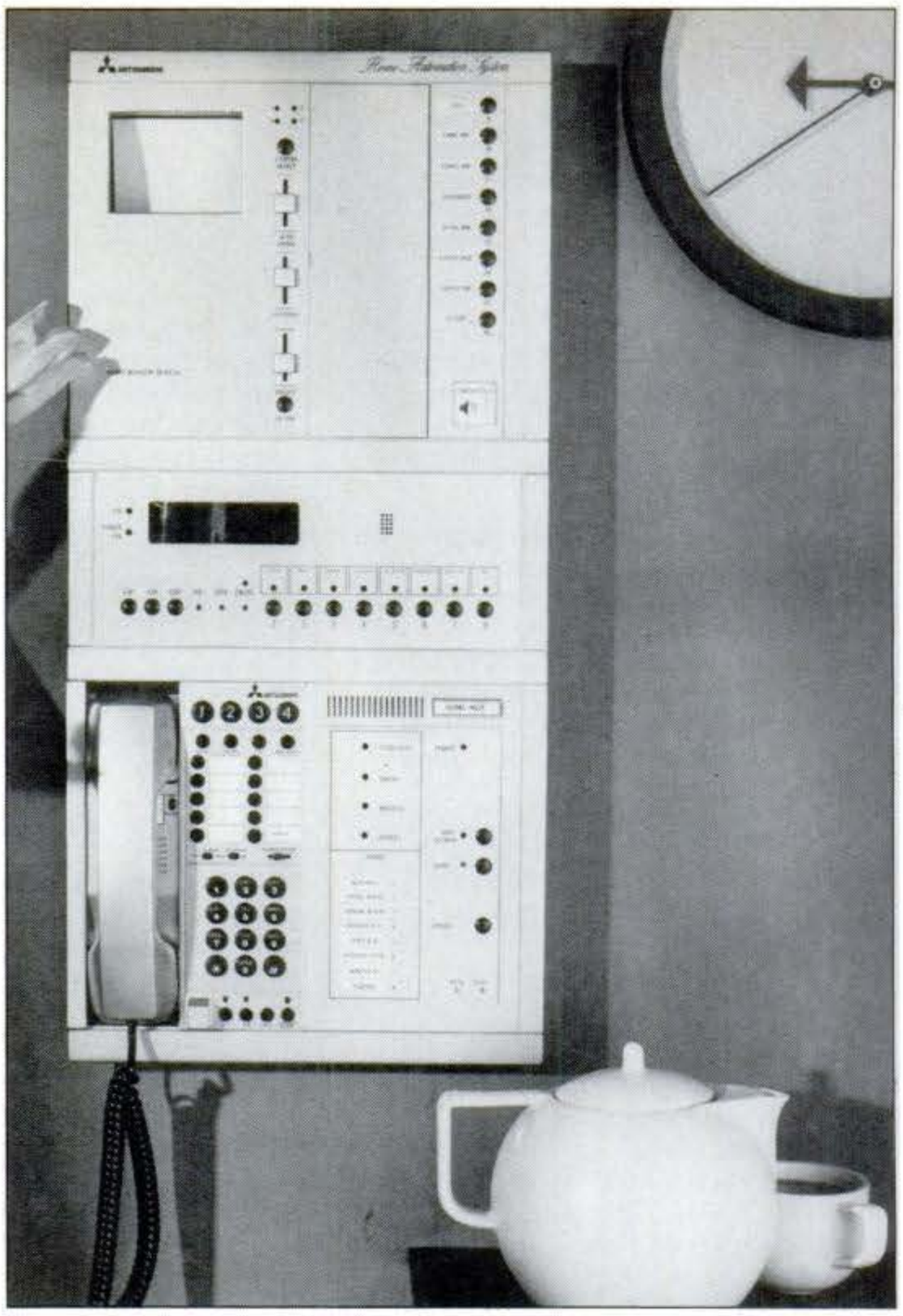
What's New in Home Improvement

BY STEVEN ASHLEY

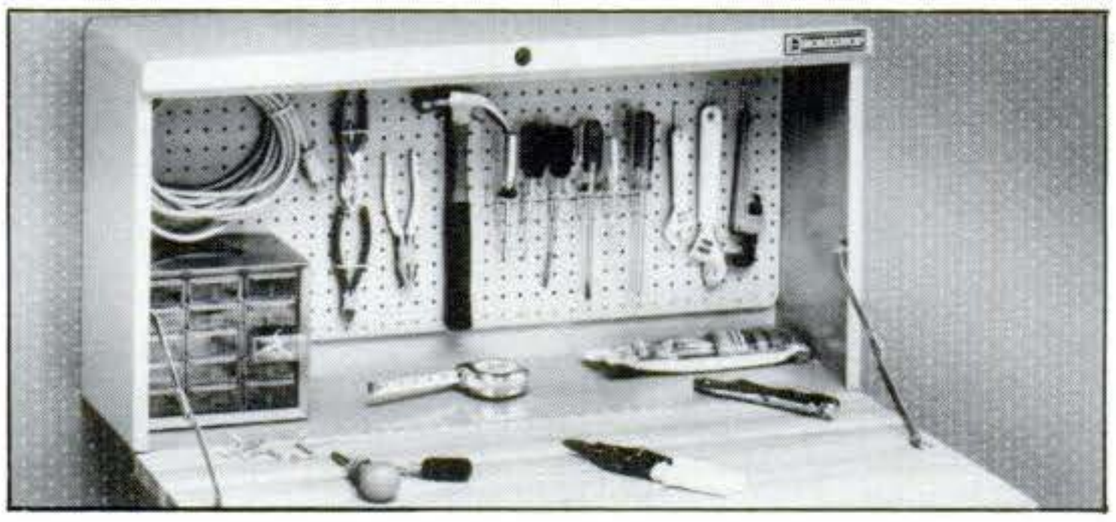
Smart house system

Mitsubishi Electric Sales America (Box 6007, Cypress, Calif. 90630) has developed a home automation system that can control almost any appliance or system in a house. A $1,200 master console is linked to special-purpose modules (which cost extra) through phone jacks.



Sink cuts corners

The Venus sink from Villeroy & Boch (Interstate 80 at New Maple Ave., Pine Brook, N.J. 07058) saves counter space by fitting into corners. The 39-by-20-in. basin is constructed from durable easy-care Asterite, a 70% quartz and 30% acrylic mixture. $835 (cutting board optional).



Wall workshop

The Homeshop multi-use tool cabinet/work surface can be mounted on any studded wall. The 40-by-19⅝-by-11-in. cabinet weighs 54 lbs. It includes a cam lock and key, perforated-board back, and hangers. Made by Delta, Inc. of Arkansas (Box 3098, Jonesboro, Ark. 72403); $100.

Sliding window

Get the look of casement windows at lower cost with the Vista horizontal slider window from Caradco (Box 306, Champaign, Ill. 61820). The exterior of the pinewood frame is clad with aluminum. The stiles are dual weather-stripped. A 4-by-4-ft. unit costs $247.

Plug-in range discs

Caloric Corp. (403 N. Main St., Topton, Pa. 19562) has introduced solid-disc stovetop elements that plug directly into the bowl cutouts of current Caloric electric coil ranges. The interchangeable elements come in 6- and 8-in. sizes. A package of two will cost less than $75.

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Motorcraft spark plugs.

THE LIGHTNING BEHIND ITS THUNDER.

It stormed onto the American performance scene. The Thunderbird Turbo Coupe, moved by a sophisticated four-cylinder turbocharged engine that's as powerful as a V-8. And the lightning behind its high-revving thunder: Motorcraft extended-tip spark plugs. Their nickel-chromium-alloy electrodes are designed to cope with the intense heat of today's high-performance engines. There's a Motorcraft spark plug, as well as a full line of quality-made Motorcraft parts, available for all makes of cars and trucks.

Motorcraft from Ford

EXCEEDS THE NEED

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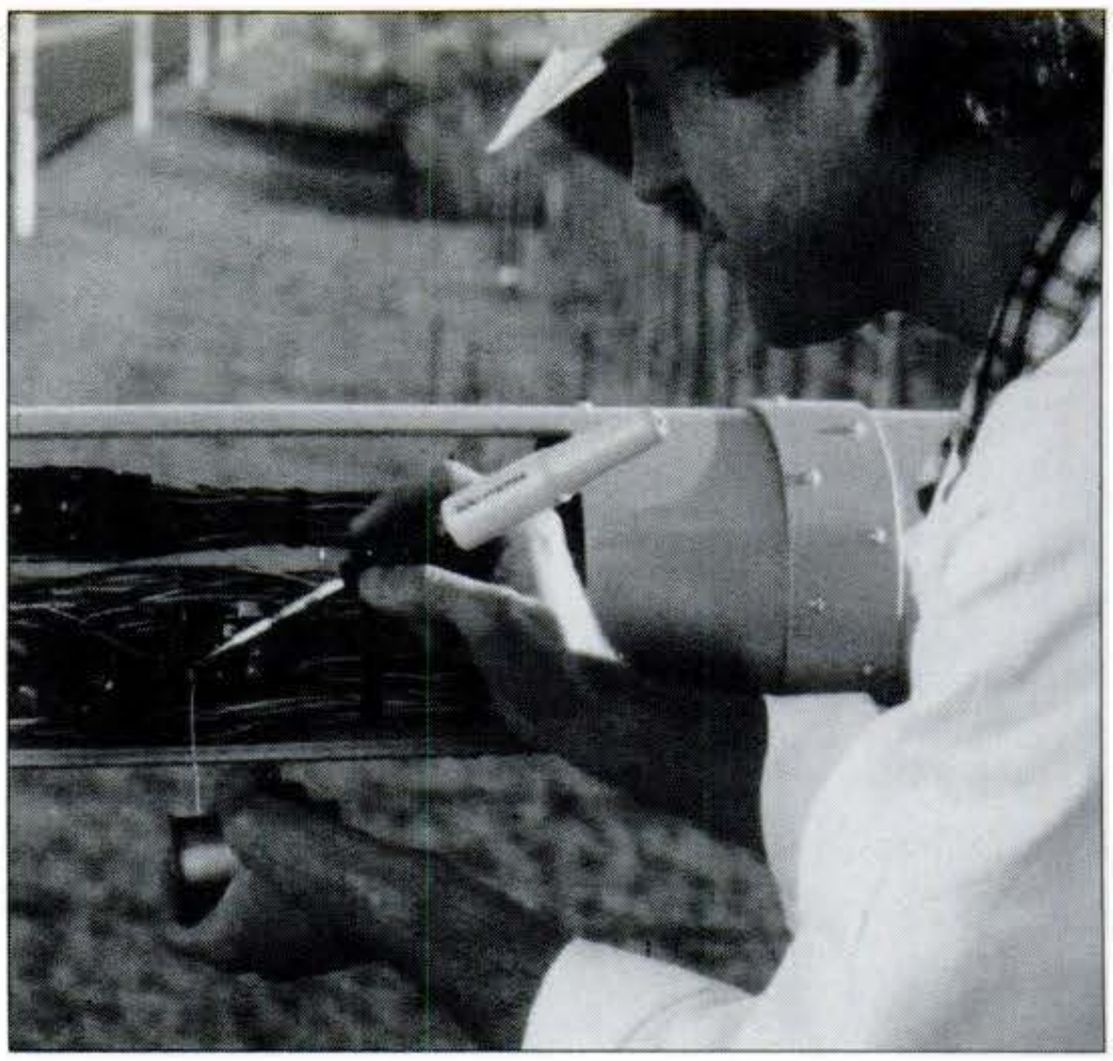
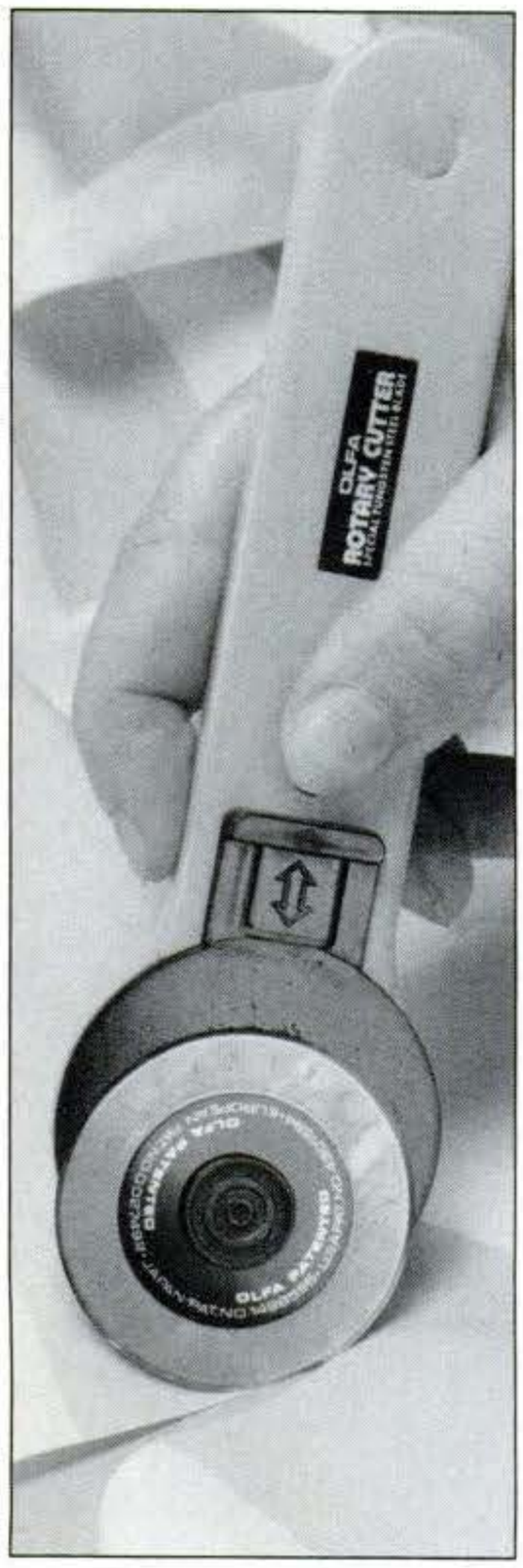
What's New in Tools

BY V. ELAINE GILMORE

Field hand

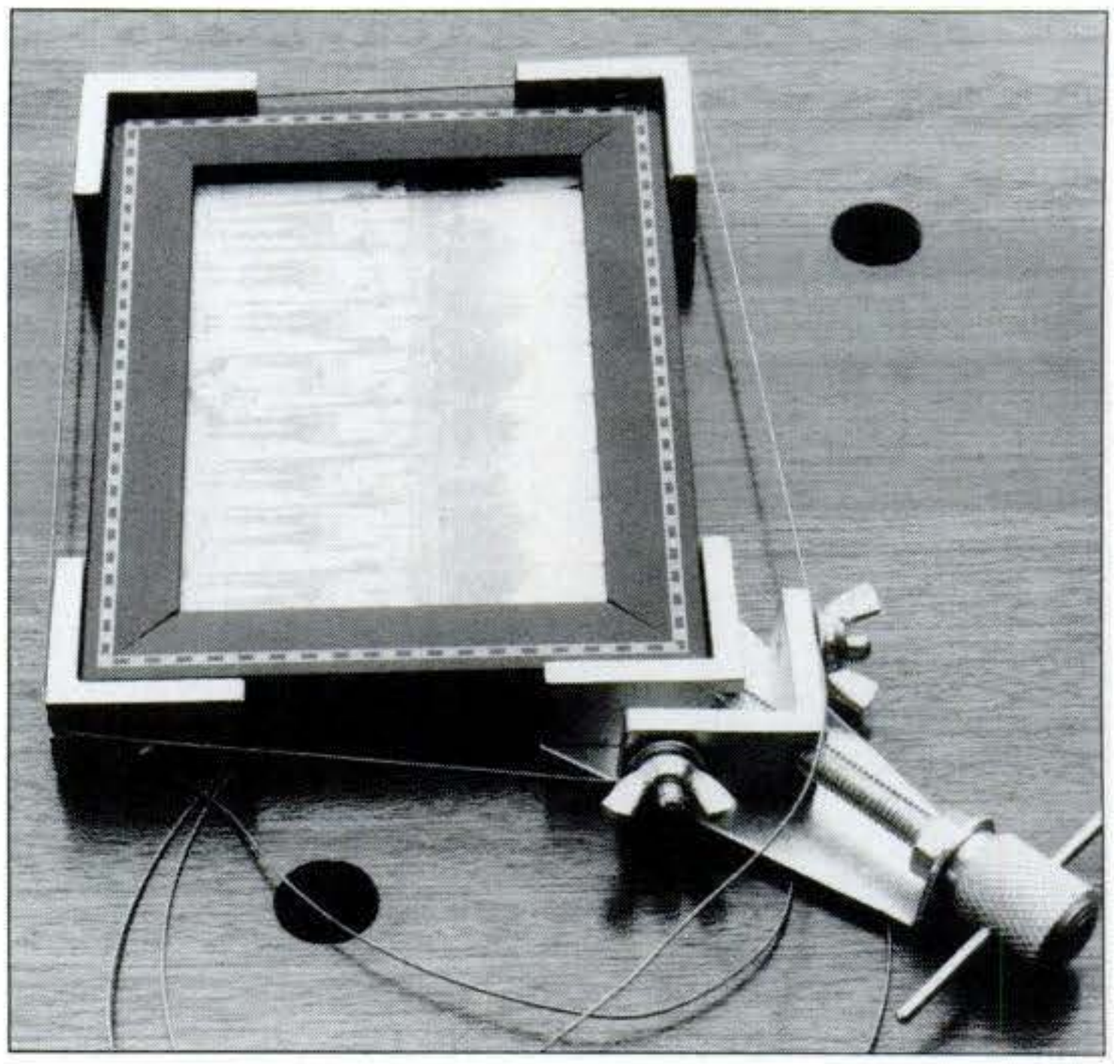
The 9⅝-in.-long Weller Pyropen is a catalytic soldering iron, torch, and hot-air gun. It can operate anywhere, powered by liquid-propane gas. Temperature range is 392° to 932° F. Many tip styles are available. Made by Cooper Group (Box 728, Apex, N.C. 27502), it's about $74.





Not for pizza

... but the Olfa Rotary Cutter slices canvas, leather, fabric, paper, and even thin metal—cutting straight or curved lines—claims Olfa Products Corp. (Box 747, Plattsburgh, N.Y. 12901). The cutter shown is about $13; a smaller model is $9. Special cutting mats are available.

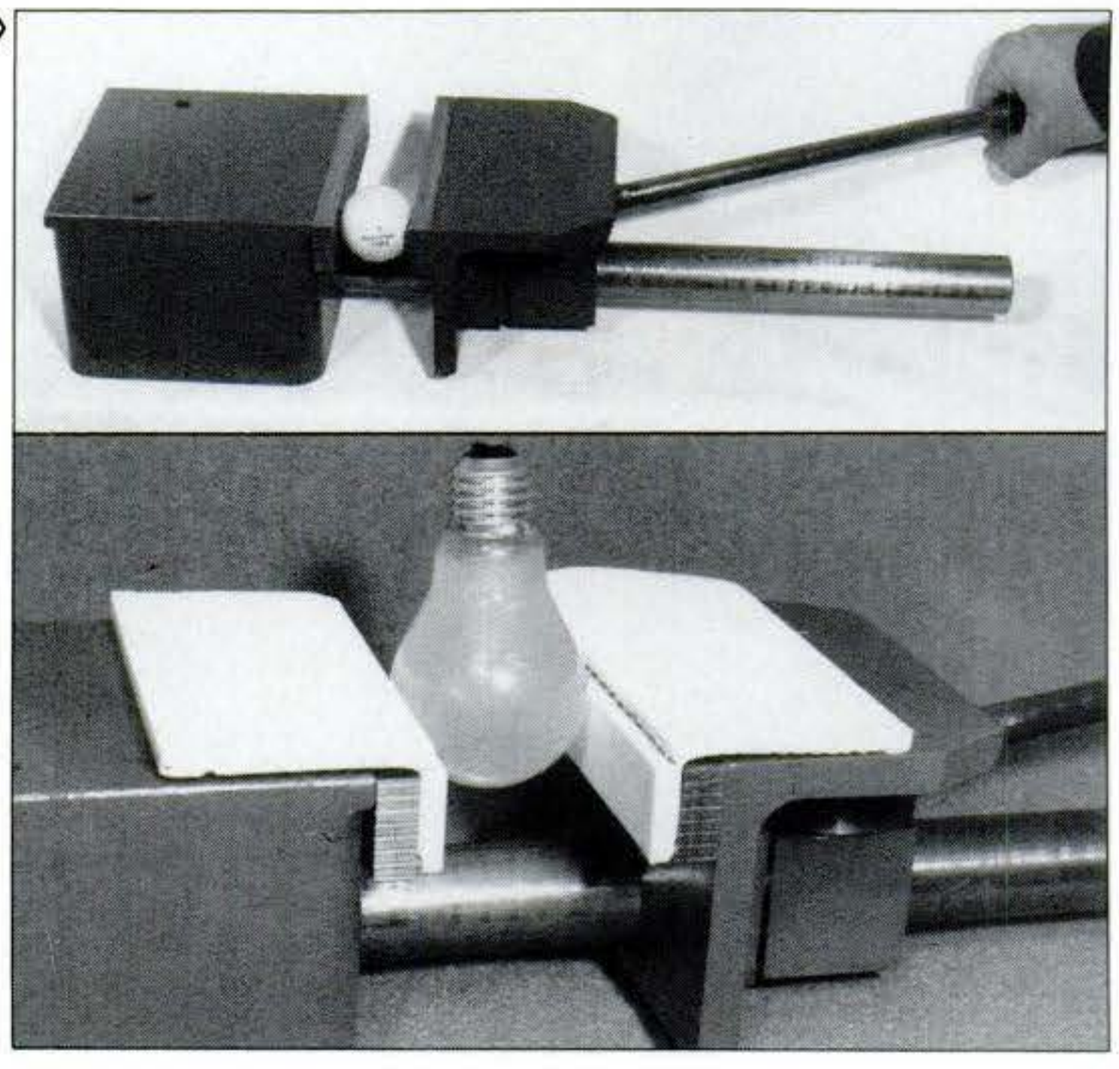


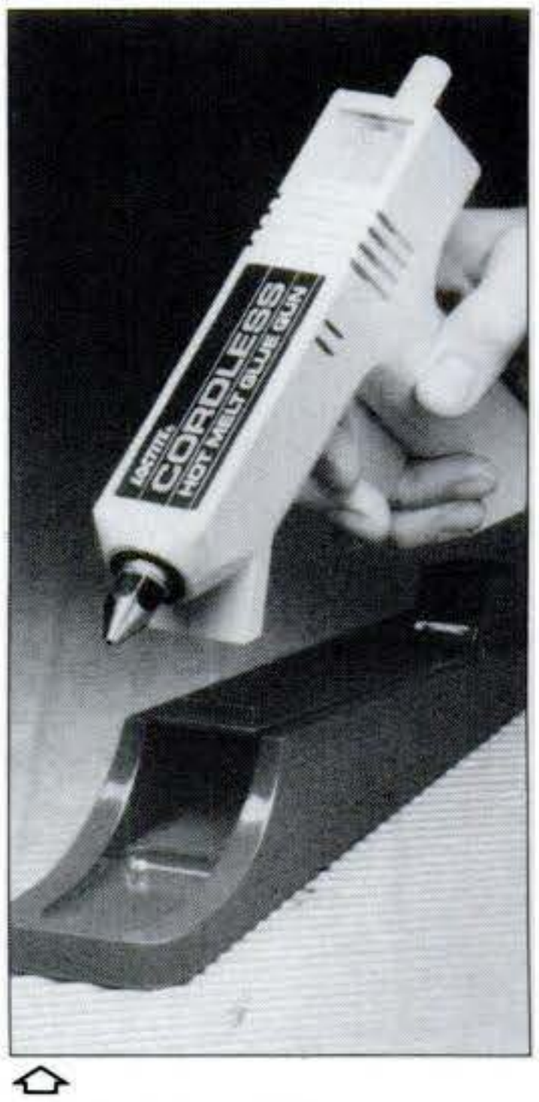
Expandable clamp

This framing clamp comes with 6 ft. of picture-hanging wire, but you can use any length—and clamp a frame of any size. You tighten the clamp by turning the knurled handle. It's $26.30, plus shipping, from Garrett Wade (161 Ave. of the Americas, New York, N.Y. 10013).

Vise and cushion

Fast-Grip vise has a sliding jaw that you close and lock with a simple push-and-swing movement of the long handle. A camlike ring tightens on a split-cylinder joint to lock the jaw in place. The Swedish vise has an 11-in. jaw opening. Add vise pads (bottom), and any vise can grip a delicate, irregular, or sharp-edged workpiece securely and without damage. The pads are made of polyurethane with a steel honeycomb core that deforms to absorb up to 14,000 lbs. of pressure, returning to original shape when pressure is released. You cut the pads to size with a saw. The vise ($295) and pad ($20) are sold by Super Cushion (Box 302, Ramsey, N.J. 07446).





Cordless glue gun

You can use Loctite's glue gun far from an AC outlet. And it doesn't have a battery. A block of aluminum in the gun heats up (to 380°F) when the gun's in the power base, and stays hot for 15 min., claims Loctite Corp. (4450 Cranwood Ct., Cleveland, Ohio 44128). It's $20.

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Trade Show Case

He designed it for trade shows after one of the biggest embarrassments in his career.

Spending $3,589 for a briefcase was ridiculous. "I lost sight of the costs."

By Joseph Sugarman

Cliff is a friend of mine who attends trade shows and conventions. One day, in the middle of a large crowd, while he was searching for a paper, the entire contents of his briefcase spilled all over the convention floor. "It was the most embarrassing moment of my business career," confided Cliff, "for at the same time, out fell my red underwear."

Determined not to let this happen again, Cliff decided to design a briefcase that he could take to trade shows and that was actually designed for trade shows. "I was going to design a custom case regardless of the cost."

EXECUTIVE TORTURE

Cliff designed a case with all Velcro fasteners so there's nothing to snap or unbuckle. He also designed it with the lightest yet strongest material he could find—420 denier nylon—material that could withstand torture and still look like new.

To carry the case, he made two provisions. One is a handle on the top of the case and the other is a strap attached to the sides. If you've ever wanted to use both hands to pick up a brochure at a booth or sign a credit card voucher at an airport, the shoulder strap lets you carry the briefcase over your shoulder with both hands free yet the strap is short enough to hang along the side.

The pockets were also designed very cleverly. First, Cliff designed a large brochure-sized pocket on the outside of the case. This way you can easily pick up brochures at a trade show, stuff them into the case's pocket—all without opening the case. This also comes in handy at an airport to hold your tickets—things you want to reach for easily.

TWO POCKETS

On the other side of the case are two pockets for convention programs, glasses or letter-sized documents or brochures. And finally on the inside, there are two compartments for holding your larger papers and documents—and large enough to hold one of those new lap-top computers. The flap that covers the top of the case also has a generous amount of Velcro so that regardless of how much or how little you have in the case you'll always be able to firmly close it and keep it closed.

And that's another point. The case expands up to 4 inches to fit its contents. More importantly, it also collapses automatically so your case never looks too big or too small for what you're carrying. And it's exceptionally light-weight—only 2 pounds 14 ounces compared to the typical 6 pound briefcase. The case measures 12" x 17."

Cliff carried his case with him to trade shows for months but he still wasn't satisfied. He refined it even further by putting a small Velcro tab on the outside pocket to give the case a better appearance while protecting the contents of the open flap and he installed a special inner compartment to hold three pens, his business cards and even a small calculator. Then he framed the entire case with rugged nylon piping—a great looking final touch.

ONLY $3,589

He finally had achieved perfection. Not only for his trade show activities but for his everyday travel and business use. And it only cost him $3,589. "I realize that's a ridiculous price to pay for a personal case but when I put my mind to something, I lose sight of the cost."

Cliff used his case for about 18 months before I met him. "A great looking case," I commented. "Where did you get it?"

Cliff told me the whole story. I was so impressed that I gave Cliff a royalty and sold the same case—not at the $3,589 that it cost Cliff but at only $69.95. I sold thousands. But I wasn't satisfied.

It was a real embarrassment for Cliff.

I found that so many people were falling in love with the concept that they wanted to use the case in place of their regular briefcase but found the 4 inch width too limiting. Many also wanted real leather instead of the artificial leather I was using. So I've designed three versions.

The first is the same one I've been offering for the past year that originally sold for $69.95 but I'm dropping the price to $49.95. The second is the version with some real leather in place of the artificial leather and an expanded 6 inch thickness for only $69.95 and the deluxe model is the full leather version for only $99.95—also with the expanded 6 inch thickness. And all versions now come in a beautiful gift box with a $200 price tag attached to the case.

CLIFF REALLY HAPPY

Order your JS&A Trade Show briefcase from me. Use it for a full month. If it doesn't replace what you currently use or if you're not completely satisfied, return the case and we'll send you a full refund. But I'm convinced that you'll really love the JS&A Trade Show briefcase for all your personal and business activities.

Cliff is quite happy now. He's making a pretty nice royalty on his case and he's really quite proud that he was the designer of what will become one of America's best selling executive briefcases. It has even changed his lifestyle. He no longer wears red underwear. Order your case at no obligation today.

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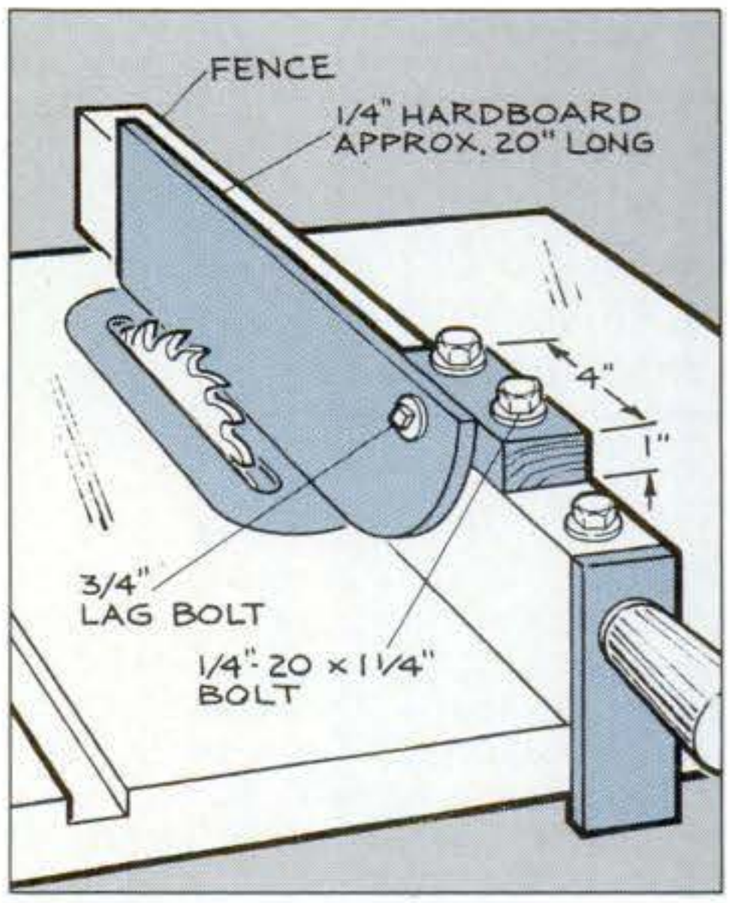
Simple hold-down for your table saw



The most frustrating thing about cutting thin strips on a table saw is that the stock between the blade and fence keeps trying to jump out. The whirring blade tends to lift the stock off the table, causing it to chatter. This chattering leads to rough edges, and in some cases the stock can shatter in your face.

A simple two-piece hold-down can solve this case of jitters. It can be used with stock up to about two inches thick, and is especially handy for ripping strips of plastic laminate for edge banding. The main component of the hold-down is simply a 20-inch length of hardboard one inch higher than your rip fence. The hardboard is lag-screwed to a block of wood bolted to the top of the fence so it pivots freely. The bottom edge of the board rests on the saw table, and the front edge is cut to a curve with a decreasing radius (the exact curve isn't critical).

When mounting the hold-down, position it so the curved front edge begins to rise off the table at the point right next to the front edge of the saw blade. Then drill and tap the top edge of the fence to accept the mounting bolts.

To use the hold-down, just feed your stock in normally, letting it push against the curved leading edge of the hardboard. The hardboard will pivot up above the stock and hold it down with a combination of gravity and leverage. For smoothest action, rub a little wax on the curved edge of the hardboard.—*A. J. Hand*

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When ESCORT was introduced in 1978, its radar warning was merely astonishing. Then the improvements began:

"If you can imagine the Turbo Porsche of the radar detectors, this is it." That was *Car and Driver's* verdict on the first ESCORT.

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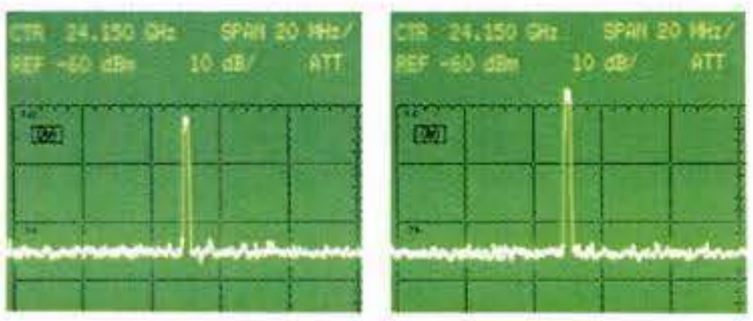
Rashid rejection too

Of course, there's more to detection than simply issuing a long-range warning. The warning must be real. No false alarms.



RADAR RASHID

Figure 1: A digital spectrum analyzer scanning the entire width of K band can't see the difference between radar and Rashid.

When the FCC cleared the Rashid VRSS collision warning system for operation on K band, there was no known way to distinguish between Rashid and radar. But our engineers came through again. Our AFR™ (Alternating Frequency Rejection) circuitry automatically isolates and neutralizes Rashid signals, yet leaves ESCORT's radar detection capability undiminished for your protection.

The full radar report

In addition to long-range warning, ESCORT also pioneered a full-disclosure warning system that tells you everything you need to know about the radar it finds. At first radar contact, the alert lamp responds and the analog meter indicates radar strength. Simultaneously you will hear an audio warning—pulsing slowly when radar is weak, quicker as you near, then constant as you approach range.

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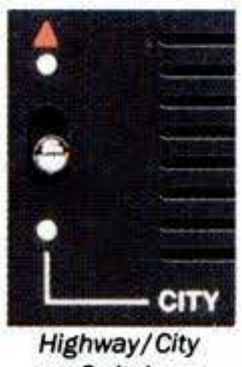

Highway/City Switch

ESCORT also provides separate warning tones for each radar band. And we've added a Mute function for your convenience: once you've noted the warning, touching a switch mutes the audio warning, yet leaves the detection circuits fully armed for the next encounter.

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Palm-sized camcorder

[Continued from page 47]

The controls are well placed—out of the way of the lens. Many camcorders I've tried have controls on or near the lens, making the tiny buttons hard to find and difficult to use.

One switch makes the Samsung unit different from all others. Throw the switch, and with the addition of an external 2.5-inch color TV (see inset), the camcorder becomes a portable VCR. "You could use it at sports events," says Kobes, "to record parts of the game as you watch it."

I'm not *that* dedicated a sports fan, but for travelers it could make a good time-shift machine for long hotel stays, provided there's a strong signal: The dipole antenna is a poor substitute for cable TV. "You could have problems getting good reception," admits Kobes. "For that reason, the TV might be cut from the final design, and only the LCD screen would stay."

Why DAT?

One of the secrets behind the unit's small size and weight is its use of the tiny 4-mm-tape cassette. However, according to Kobes, that's not the only reason the DAT format was chosen. "We wanted to develop hardware that could use video or audio software," he says. "DAT tape is already in development, and we expect it to become widely available soon."

What's the advantage of using one type of tape for both audio and video recording? "You could have one DAT playback unit in your home," says Kobes. "Play digital audio tapes on it, or, at the flip of a switch, watch a videotape." Prerecorded movies on DAT? "No," says Kobes. "It will be for home-movie use only."

At present, the camcorder is still in the development stage. An even earlier design that uses a built-in TV-tuner was shown last year at the Korean Electronics Show. And one other model with an LCD viewfinder is planned. "The final design decision hasn't been made," says Kobes. "We're testing each to see which is more appealing to consumers."

Despite the small size and TV option, the machine's success is a gamble. It relies on the acceptance of DAT and on Samsung's ability to outsell all VHS and 8-mm makers. That could be a tough battle, but I suspect Samsung is fighting a different war—and believes it has already won. "Up to now, Korea has been a follower," says Kobes. "This is a first."

Samsung Electronics America, Inc. (301 Mayhill St., Saddle Brook, N.J. 07662) will sell the camcorder this fall in Korea, and next spring in the U.S. for about $1,300. The optional TV will be about $350. PS

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Erasable optical discs

[Continued from page 58]

changed the thin film's polarization without using the customary magnet. Pulsing the laser for a shorter duration at the same spot flipped the polarity again.

Kryder explains their discovery this way: "We're taking advantage of a property of all thin magnetic films. They have an internal magnetic field, called a demagnetizing field, that's opposite in direction to the observed magnetic field at the film's surface." Because of this particular film's composition, the internal demagnetizing field becomes strong enough to reverse the surface magnetization when it's heated to a certain temperature by a laser. Kryder is working with several thin-film combinations to optimize this technique.

Watch out, Winchesters

"Direct overwrite will not be in the earliest magneto-optic devices," says Kryder. "It takes industry a couple of years to turn something into a product." Carnegie-Mellon University (CMU) is working with optical-disc companies, including IBM Corp., Hewlett-Packard Co., Verbatim, and General Electric Co. If the CMU achievement bears out—if overwriting can be done in one pass—"you will have something functionally equivalent to a Winchester and a backup [tape system]," says Leonard Laub, president of Vision Three, Inc., a Los Angeles consulting company specializing in storage technology and applications. "My guess is that when that technology is available, it has a good chance of penetrating the mainstream of small Winchester markets," Laub says.

You may never see CMU's technology in home or other less-demanding desk-top computers. According to Rothchild, in these machines, which run much slower than main-frame rates, the delay needed for two passes to erase and write—a few milliseconds—is unnoticeable. "The new information is written into a buffer [semiconductor memory] rather than directly to the disc. Then, under the control of operating-system software, the previous data are erased and new information is written," says Rothchild.

The access rates—how fast you can retrieve information—tend to be slower for optical drives than for magnetic ones. That's because the complex laser head is heavier and clumsier than a magnetic head; it takes more time to move to a specific spot on a disc. But access times will shorten as optical heads are lightened.

Differences in access rates may also

Continued

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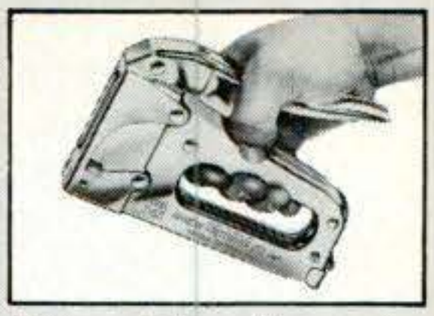

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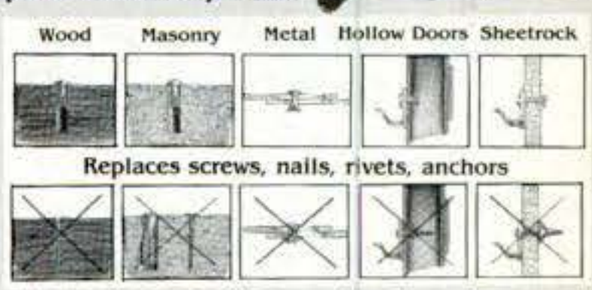

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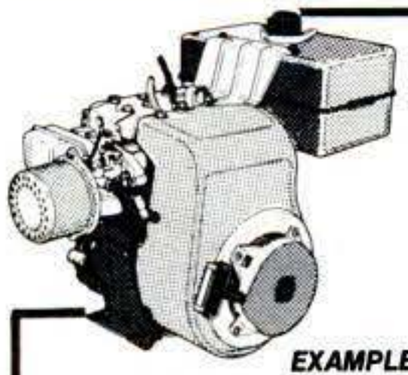

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be irrelevant: Because of the greater recording densities of optical discs, an optical head has more information "in sight" than a magnetic head. Thus Rothchild argues that "what you should be talking about is access time per ten megabytes. On that basis, the optical drives today are a hell of a lot faster than the magnetic drives."

Fortunately, you won't need a new computer to use magneto-optic drives. Says Geyer of the Verbatim system: "It takes a screwdriver to put it in. There are no changes in your operating system; you don't even know that it's an optical system."

Verbatim is clearly targeting the home or small-office user market by emphasizing the 3½-inch discs and half-height drives made familiar by the Apple MacIntosh. Verbatim's first erasable drive will be a single-sided version, but the company plans to follow with a two-sided version with 50 megabytes of storage capacity on each side.

Three-way drive

You get a different message, however, after driving one exit down Route 101, Silicon Valley's Main Street, to visit Optimem in Sunnyvale, Calif. This company, originally spawned by Xerox Corp., is owned by Cipher Data Systems, and now makes optical disc drives. Larry Fujitani, Optimem's director of marketing, says Optimem—in concert with 3M Co.—is developing a "multifunctional" optical disc drive, meaning a drive that can use read-only, write-once, and erasable optical discs.

Optimem is developing the drive, and 3M the recording media. The system uses 5¼-inch discs, holding about 250 megabytes of data. The drives are intended, says Fujitani, for the high-performance end of the marketplace—businesses with very large data needs or those requiring the power of main-frame computers. Optimem's multifunctional drive will let engineers, for example, obtain data on read-only discs, dump it to an erasable disc, modify it, then permanently store it on a write-once disc.

This idea of a multifunctional drive is also attractive to Matsushita Electric Corp. of America's Anthony Jasionowski, manager of recording technology there. "Matsushita already has a write-once phase-change drive called the optical memory disc recorder," he says. "If we come out with an erasable system that employs the same recording mechanism, we'd have a compatible drive that could read and write erasable and write-once discs."

As with all new technologies, there are still some snags. One problem is manufacturers using different standards for disc formatting. As a result, there may be many incompatible drives. Although efforts are underway to set a standard, both Geyer and Fujitani are discouraged by the slow pace.

Another concern is the stability of erasable optical discs. Magneto-optical recording requires some extremely reactive materials, such as terbium. "This," says Victor Jipson, manager of optical storage science and technology at IBM's Almaden Research Center in San Jose, Calif., "is like sodium or magnesium. It's one of the more reactive elements in the world. So it's a significant challenge to figure out how to protect these materials without degrading performance."

"Right now," says Vision Three's Laub, "manufacturers, instead of guaranteeing that their formulations are perfectly stable, are encapsulating [enclosing disc surfaces with a protective material]. I can't say that's a bad thing to do; it's just not elegant." Geyer at Verbatim doesn't believe corrosion is a limiting factor.

But stability is one incentive for developing dye-polymer systems. These materials will not corrode or rust like terbium and other materials used in magneto-optic and phase-change systems. Dye-polymer discs would also be less expensive to manufacture because of low material costs. Currently, the limiting factor for this technology is the number of times you can erase and rewrite. "In time we end up with an artifact on the disc surface because the erase beam begins to grow its own bump and leave a mark in addition to the desired mark," says Donald Matson, president of Optical Data, Inc., in Portland, Ore. Because no polymer chains are broken in the media, he adds, the problem seems to be solvable by improving the quality of the optics used. "In the derby for an erasable winner," he says, "the order is as follows: the magneto-optic, which has thirty years of experience; the phase change, which is about fifteen years old; and our technology, which is about four years old."

But what do you do with a 3½- or 5¼-inch erasable optical disc that can hold 10 times more information than your Winchester, or the equivalent of about 250 floppies? There are many possibilities. Several companies—RCA Corp., KDD in Japan, and apparently governmental intelligence agencies—are looking at erasable optical recording for capturing and storing satellite data in real time. However, high data transfer rates are needed if erasable optical systems are to serve as "in-baskets" for satellites. Accordingly, RCA has developed a system in which an array of at least nine write heads simultaneously dumps data onto different tracks of a magneto-optical disc.

That seems remote from home applications, but an obvious possibility is the use of satellites to deliver movies, engineering data from the Tokyo office, or a lengthy legal opinion from the London firm onto your erasable optical discs for playback on your television set or computer screen.

Beyond this possibility, there are others closer to reality: Sony Corp. and Canon have both announced electronic cameras that have magnetically stored images [PS, Oct. '86]. The next step is to apply erasable optical technology. "The application would be for setting up a shot, taking a quick picture, adjusting for framing and lighting, then using conventional color film," says Rothchild. It also might be feasible to make a magneto-optical version of play-only digital audio discs: You can make your own compact disc, in effect.

But, by common agreement, data storage is the biggie for erasable optical recording, especially digital image storage. A page with images—signatures, logos, charts—needs 100 times more memory space than the same page with only text; 12 times as much after elaborate data compression. The upshot is a reluctance to use memory-gobbling graphics that can fill your Winchester quickly. The optical discs—because they have lots of storage space and can be removed and replaced with an empty disc—do away with the problem.

Erasable optical disc drives are likely to cost more than Winchesters, but because of their capacity will cost less if measured on a cost-per-bit basis. Fujitani expects that Optimem's multifunctional drive will be priced at $10,000 to $20,000 initially, but that like any other product, the price will migrate down with time. "You'll eventually see it approaching the $3,000 to $5,000 range," he says.

When will this optical revolution begin? Both Optimem and Verbatim say they expect to send prototypes to customers late this year and to go commercial in early 1988. Predictions on how fast these systems will catch on vary. Kryder estimates that "five years from now, erasable optical recording might own ten percent of the magnetic recording market." Bill Meiklejohn, a former GE researcher who now plans to start his own company making erasable drives and media, is more optimistic. He estimates that in 10 years all magnetic recording will be gone. PS

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 [Continued from page 45]

ing at peak power, it has more than enough torque to keep the car moving smoothly.

The last car, the LeMans, proved a disappointment in the braking test, with stops averaging 184 feet. And due to short supply, we had to test a LeMans with a three-speed automatic, which handicapped it in the acceleration runs. Still, the transmission did click off crisp, clean shifts. And for those who want an automatic, only the LeMans and Hyundai offer one.

The LeMans was also the only car in the group equipped with power steering, which must be ordered if you buy air conditioning. Its light, accurate steering helped make the LeMans a satisfying car to drive through our two handling grids, even though its times weren't the fastest in either test.

On the road

Because we photographed the cars in California, then did the testing in and around New York City, we had a chance to drive two samples of each car over a wide variety of conditions. We climbed through the canyons north of Los Angeles, cruised for hours across the Mojave Desert, and sat patiently through L.A.'s infamous traffic jams. On our return east, we not only braved New York's potholes but faced near-blizzard conditions and temperatures that hovered near zero.

Through it all, we were impressed with these six minicars, especially considering that several of them list for about half the cost of an average compact. We were also pleased to find that each has its own personality. Cheap doesn't necessarily equal bland.

With a base price of $3,990, the Yugo GV is far and away the least-expensive new car sold in the U.S. For that price, you can't expect perfection. But allow for the inevitable shortcomings, and the Yugo has its merits.

For starters, if you can live without air conditioning, you can get a brand-new Yugo with cloth on the seats and carpet on the floor for well under $5,000. True, the seats *are* small, and the buslike driving position is straight from the Fiat 128. But most drivers under six feet tall managed to get comfortable eventually. And though we found the back seat cramped for two adults, the seat back does fold forward, adding to the modest trunk space.

The carburetor-equipped 1.1-liter four stumbled somewhat during warm-up, and engine noise was a constant companion. But the ratios in the four-speed transaxle were well spaced, and a heavy foot on the throttle could keep the Yugo moving with the fastest L.A. traffic. Even the ride seemed acceptable, given the car's short wheelbase.

Like a cheap garret in Paris or Rome, the Yugo had a crude Continental charm. The Korean Hyundai, on the other hand, reeked of blandness, and seemed designed to offend as few people as possible. Given that Hyundai sold some 160,000 Excels in 1986, it's hard to knock this strategy.

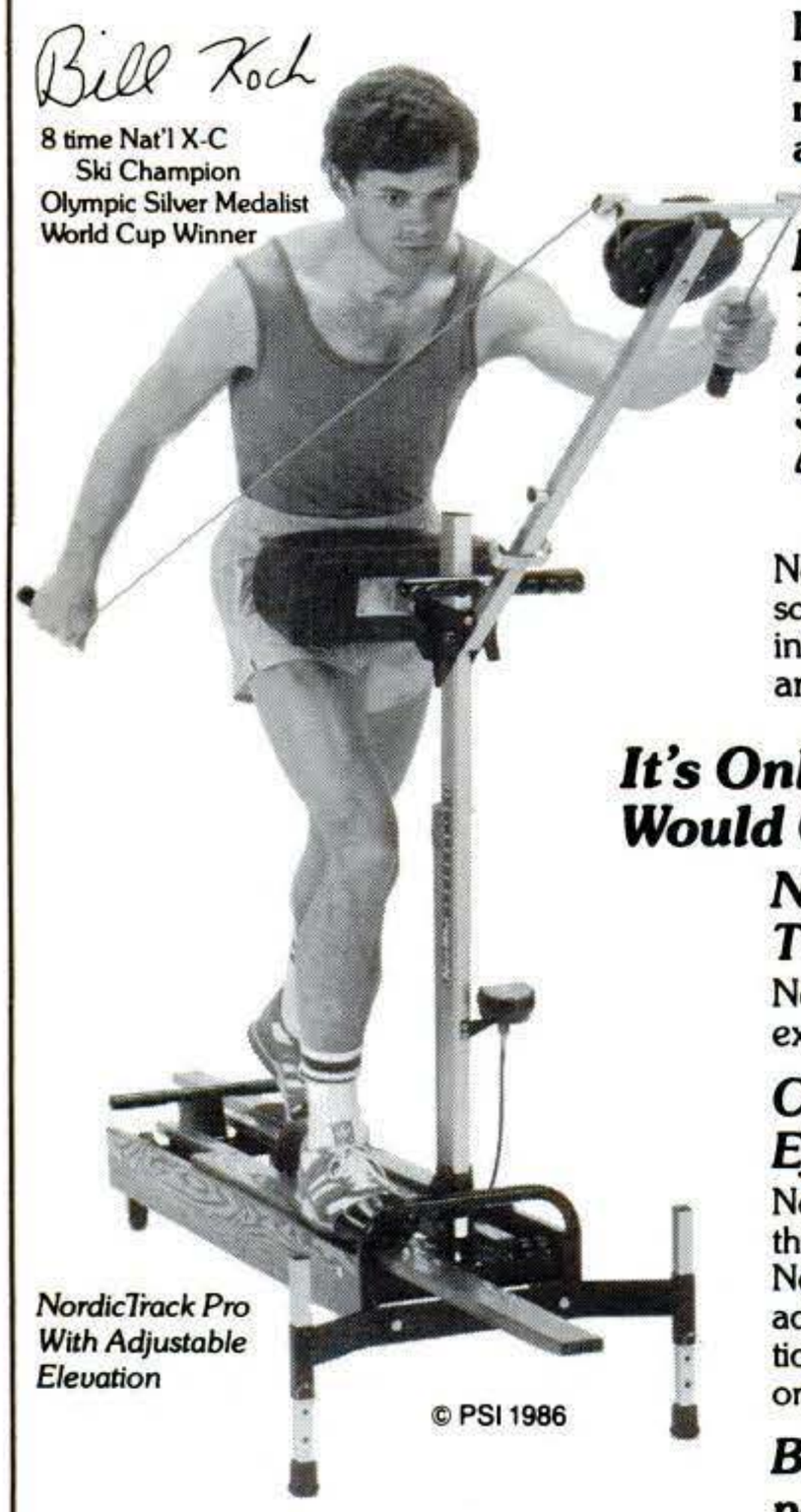
We tried the Excel two ways, plain and fancy, and ended up liking the plain car better. The photo car, a fully loaded four-door, featured every option imaginable, and carried a sticker of nearly $9,000.

At that price, the Hyundai's shortcomings started to irritate. The 1.5-liter engine, equipped with a carburetor, stumbled occasionally, and it droned loudly as it worked against the three-speed automatic. The sun roof took another inch or two out of the already marginal front head room. And the power steering felt imprecise.

Equipped like our East Coast car—a red hatchback with almost no options—the Excel suddenly seemed more attractive. The tan vinyl upholstery

Continued

Scientific Study Ranks NordicTrack #1



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looked sturdy and easy to clean, and the absence of a sun roof made the interior feel far more spacious than that of the loaded four-door. Although lack of a fifth gear made the engine sound slightly strained at turnpike cruising speeds, the noise level and overall comfort seemed fine for a car that sells for under $6,000.

Spirited shoe box

The Subaru Justy is best described as a feisty little shoe box. Its 1.2-liter three-cylinder engine and smooth five-speed transmission combined to make the Justy quick. But the engine roared loudly, and the lightweight body shell did little to damp engine, wind, or road noise. Handling on winding roads was excellent, and braking was good.

Inside, the Justy was surprisingly roomy, though the vinyl upholstery, minimal gauges, and thin plastic steering-wheel rim of the base DL version all screamed "economy car." Even the door panels were only partially covered, with body-colored steel across the top and bottom.

Still, performance and economy were the car's strong points. And like the VW Beetle, the Justy makes no attempt to hide its modest origins. No doubt many buyers will find this no-nonsense approach refreshing.

The Ford Festiva and VW Fox proved to be almost everyone's favorites during our day-to-day driving, though for very different reasons.

The Festiva is styled a bit like a telephone booth, and this height allows Ford to comfortably fit four full-size adults in a car just an inch longer than the Justy or Yugo. Seats were tall and supportive, vision was excellent, and the interior of the Festiva LX was as well-trimmed as that of any Japanese subcompact.

The Festiva's 1.3-liter four had just a trace of carburetor stumble at light throttle. But teamed with the five-speed manual (part of the LX package), the engine enabled the car to stay with any traffic flow. The engine was barely audible at idle, and it revved smoothly no matter how hard it was pushed.

Due in part to its 1,700-pound weight, the Festiva felt nimble, and it had the best fuel-economy rating of the group. Yet careful engineering seems to have eliminated the drumming and banging usually associated with such light cars; the Festiva was far quieter than the similar-size Yugo and Justy. Indeed, the Festiva appears to be a breakthrough in the search to build light cars that don't feel flimsy.

Unlike Mazda and Ford, which broke new ground with the lightweight Festiva, VW pursued a more traditional approach with the Fox. The car felt substantial because it was—it tipped the scales at almost 2,200 pounds. And it performed well because it had the most powerful engine in the group.

We found only two faults with the Fox: First, as you might expect, fuel economy was only average. Also, the junior Jetta styling resulted in a cramped interior, one that drivers over six feet tall found hard to live with. Still with its smooth engine, quiet ride, and luxurious interior, the Fox felt almost like a baby Mercedes. At $5,690 for the two-door, it's a lot of car for the price.

Finally we come to the LeMans, a car that Pontiac seems determined to price right out of the low-cost market. Based on the German Opel Kadett, the LeMans retains a European look and feel. That's both good and bad. The interior was roomy; the cloth upholstery was tasteful and subdued; and the gauges and controls were

Continued

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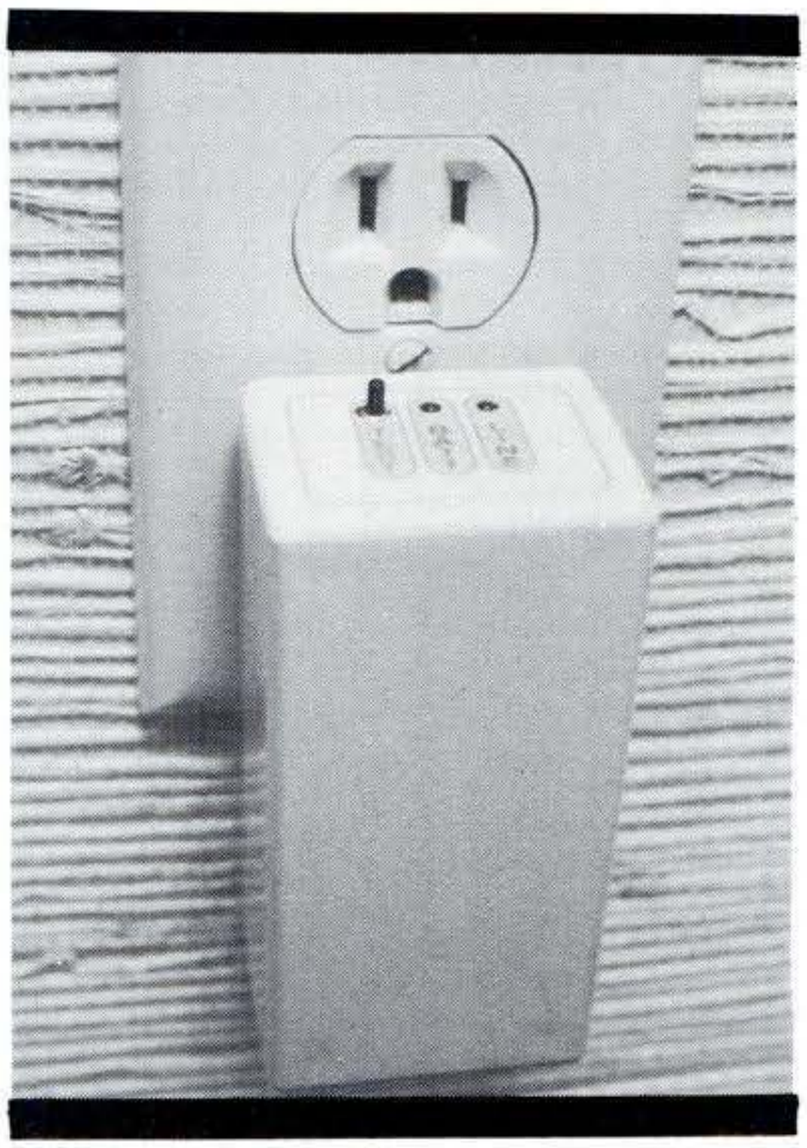

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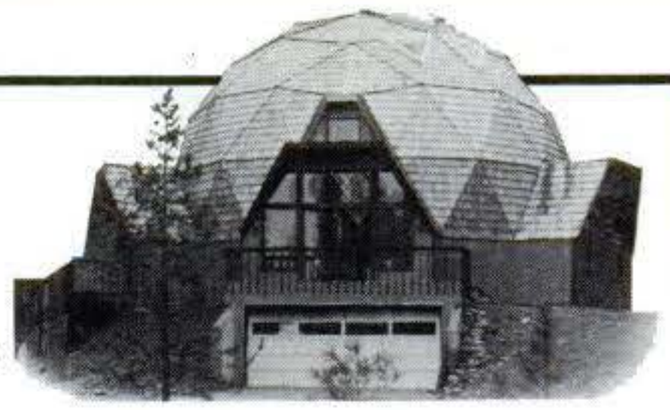

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Minicar invasion

Continued

placed logically and worked beautifully. And the quirky exterior styling, especially of the two-door, certainly helped the LeMans avoid the ho-hum looks of many Japanese and domestic small cars.

Unfortunately, the LeMans also inherited several flaws typical of many small European cars. Its 1.6-liter engine roared loudly during acceleration, and the car tended to thump and drum on rough roads. Also, the overall fit and finish weren't quite up to that of the Festiva, Justy, or Fox.

The LeMans, with its as-tested price estimated at $9,000, illustrated the same problem we found with the fully loaded Excel: Start checking lines on the option list, and soon the car doesn't seem like much of a bargain. Show a little restraint, though, and there's plenty of value in any of these cars. After all, you can buy the whole group of cars for less than you'd pay for a single Mercedes-Benz 300E.

Cost considerations

Finally, keep in mind that inexpensive transportation involves more than just a low sticker price. A recent survey done by Hertz found that depreciation—the difference between what you pay for a car new and what you can sell it for years later—contributes most to driving cost. Insurance comes in second, followed by gasoline. Maintenance is fourth.

All of the cars in this group are too new for anyone to accurately predict how well they'll hold their value, or how well they'll stand up to years of driving. So some buyers might prefer to spend more for an established model, stretch the payments another year, and bet on proved durability and resale value to offset the higher initial cost.

On the other hand, a rock-bottom base price has its allure. The cars in this group generally performed well in our critical handling and braking tests, and several were unusually quiet and comfortable. And coming from all corners of the globe, these newest minicars certainly offer a variety of choices for those looking for basic transportation.

Authors' picks

I choose the Justy. It delivered the best all-around performance of this group at the test strip, and Subaru has a relatively well-established dealer network.—*J. J. K.*

The Fox is precise, smooth, and sophisticated—and probably Volkswagen's savior.—*D. McC.*

The Festiva is light, quick, quiet, and comfortable. What more can I ask?—*T. W.* PS

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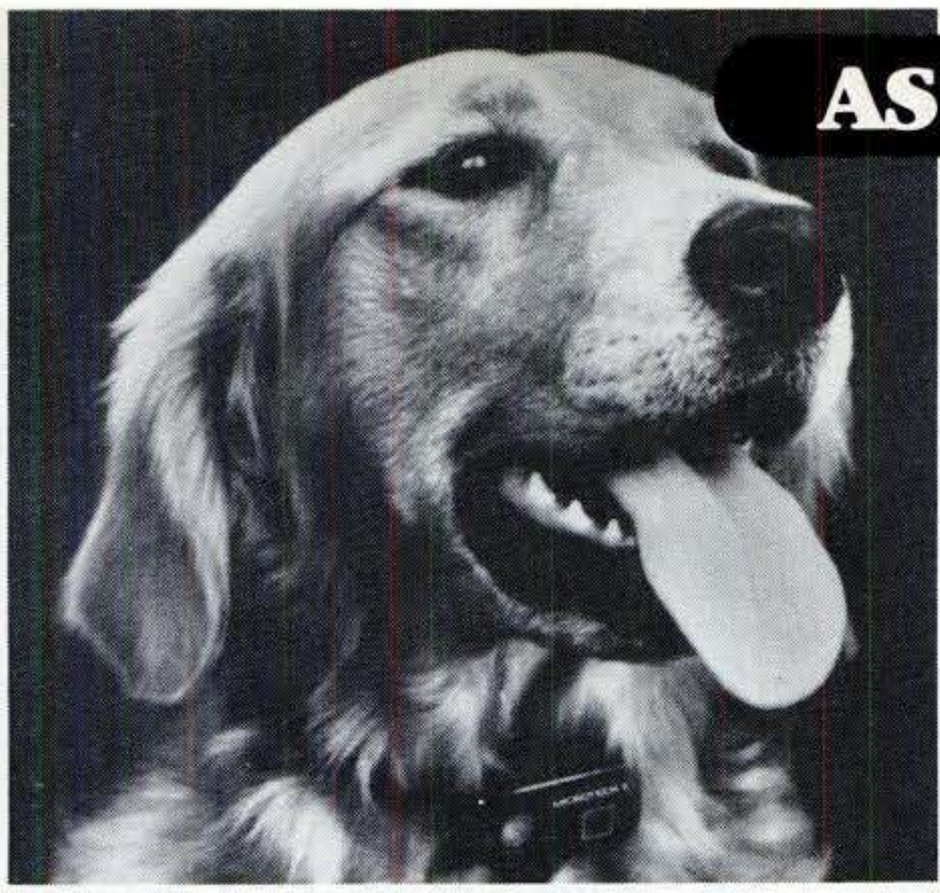

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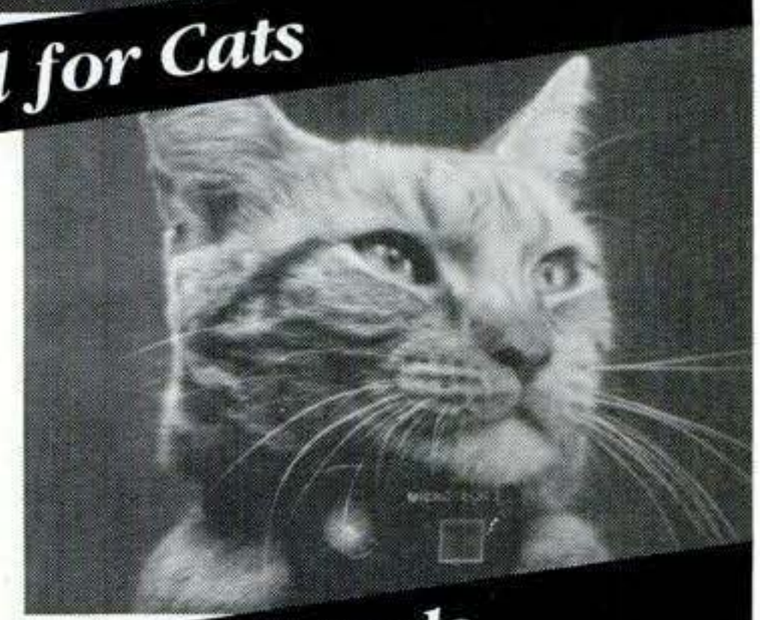

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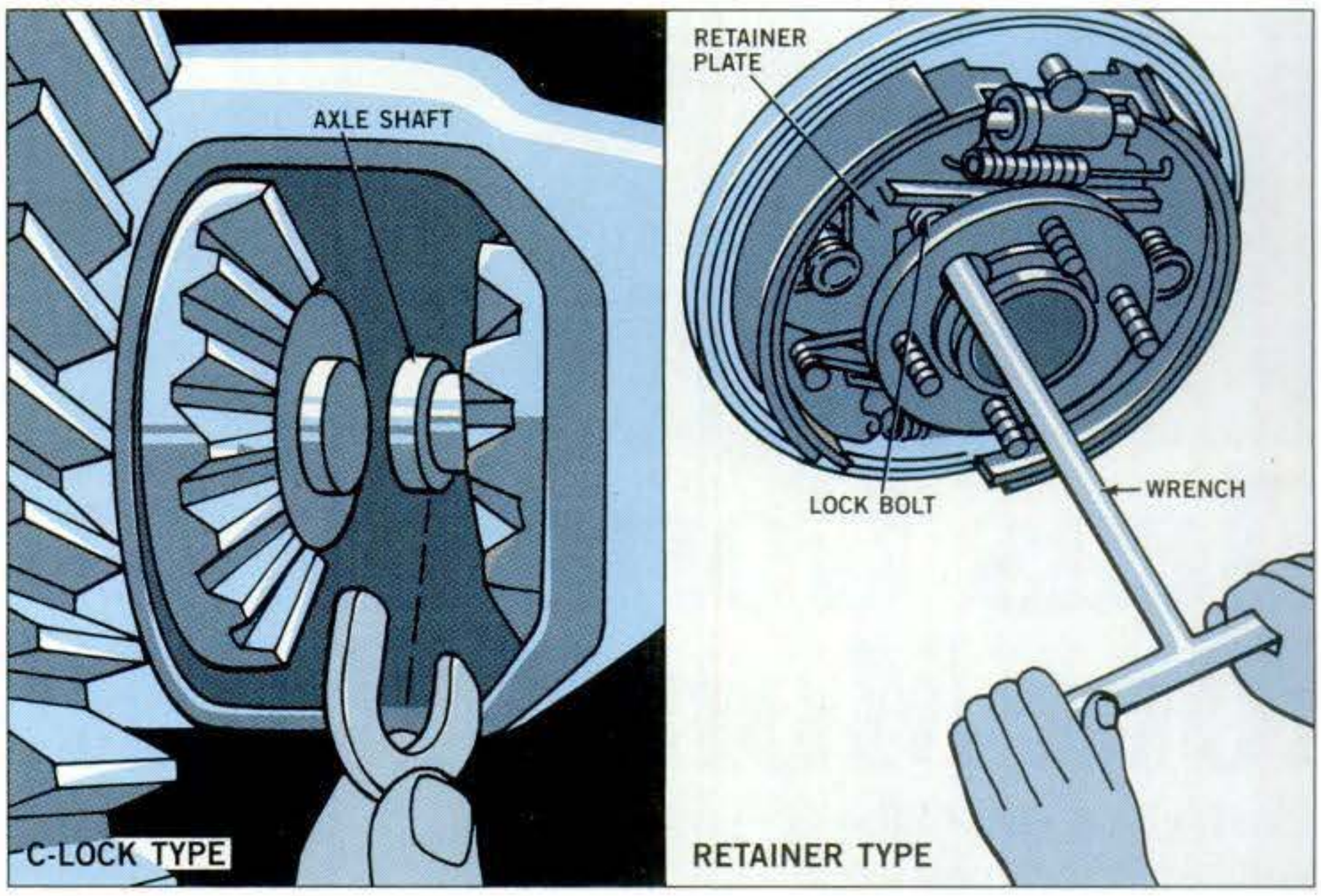
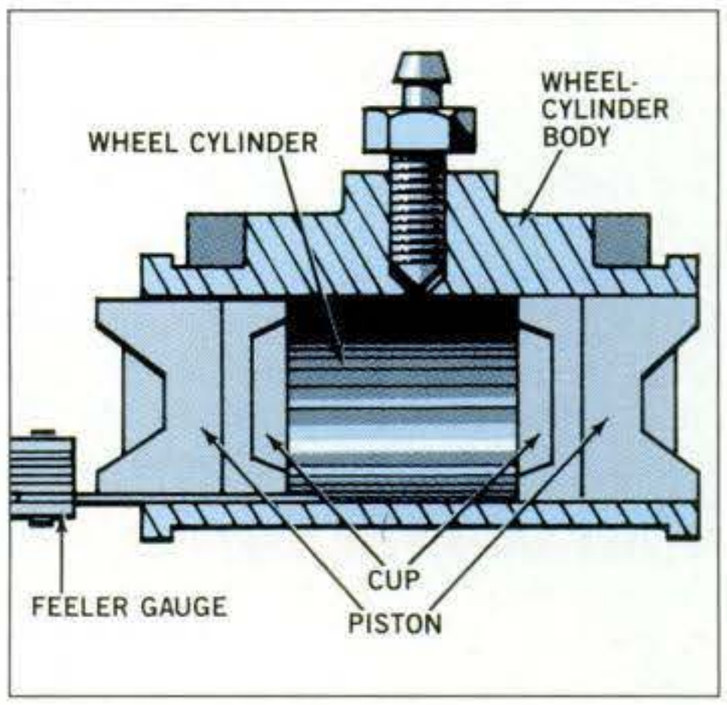
By STEVE MERCALDO



Removing rear axles

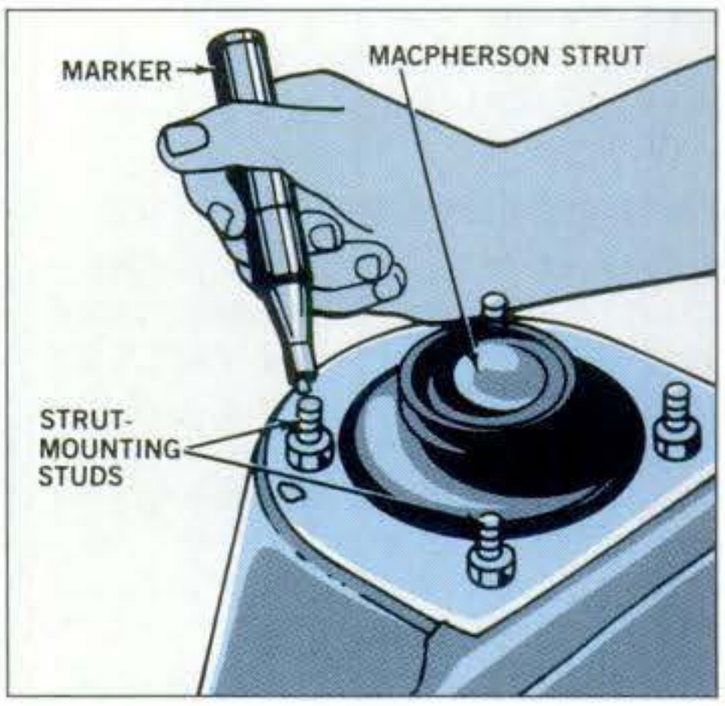
Two methods are used for removing the rear axle in a rear-drive car. To remove an axle held by a retainer plate, remove the plate's screws. Then use a slide hammer to pull the axle from the housing.

An axle secured by a C-clip is a bit more difficult and messy to remove. First, drain the differential oil and remove the differential cover. Then remove the differential pinion-shaft lock bolt and push the pinion shaft out of the carrier. Finally, push the axle in toward the carrier and remove the C-clip. The axle can then be pulled from the carrier assembly by hand.



Brake wheel-cylinder wear

Check the clearance between the wheel-cylinder bore and piston after honing. If the clearance exceeds 0.005 inch, replace the cylinder. Excessive clearance can cause a condition known as heel drag, which results in slow retraction of the piston. This causes rapid wear of the brake lining and possibly dangerous brake fade.



Strut stuff

Misalignment can result from a failure to reinstall a MacPherson strut in its original position after service. To ensure proper positioning, mark one of the mounting studs and any alignment adjustments *before* removing the strut assembly. Also, prior to disassembling either strut, mark left and right side springs.

Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay $50 if we use it. No tips can be returned.

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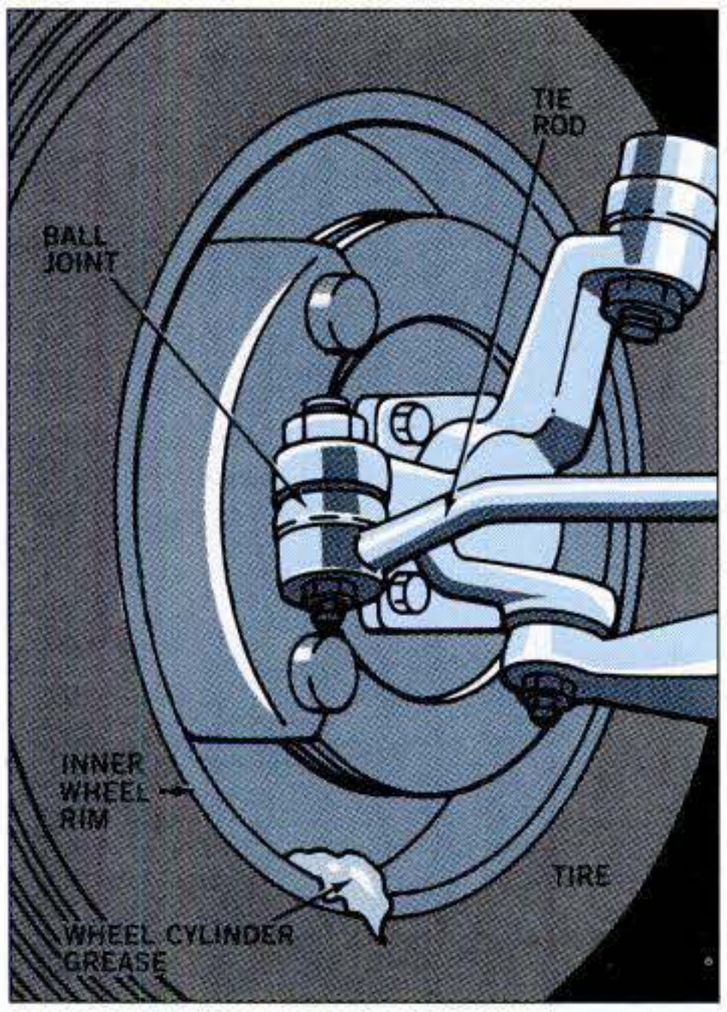
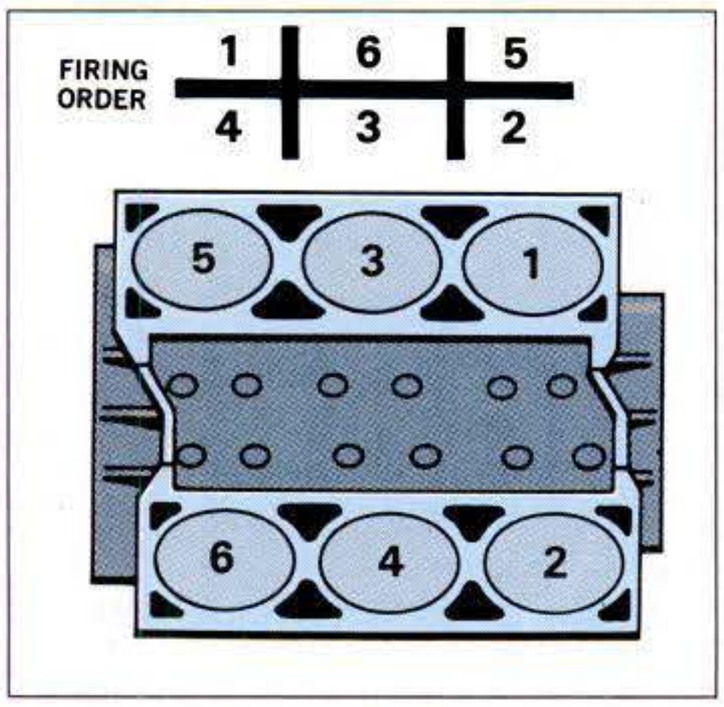


Lube-job imbalance

Vibration of the steering wheel at highway speeds generally indicates an imbalanced wheel. Before running to the shop for service, examine the inside of the front wheel rims for grease overflow from a nearby bushing. Even small deposits of grease can cause the steering system to shake.



Companion cylinders

During the servicing of an engine, it's sometimes advantageous to know which two opposing cylinders operate together. (One piston rises on the exhaust stroke, the other on the compression stroke.) A quick way to discover the cylinder relationships is to halve the firing order, placing one set of numbers on top of the other.

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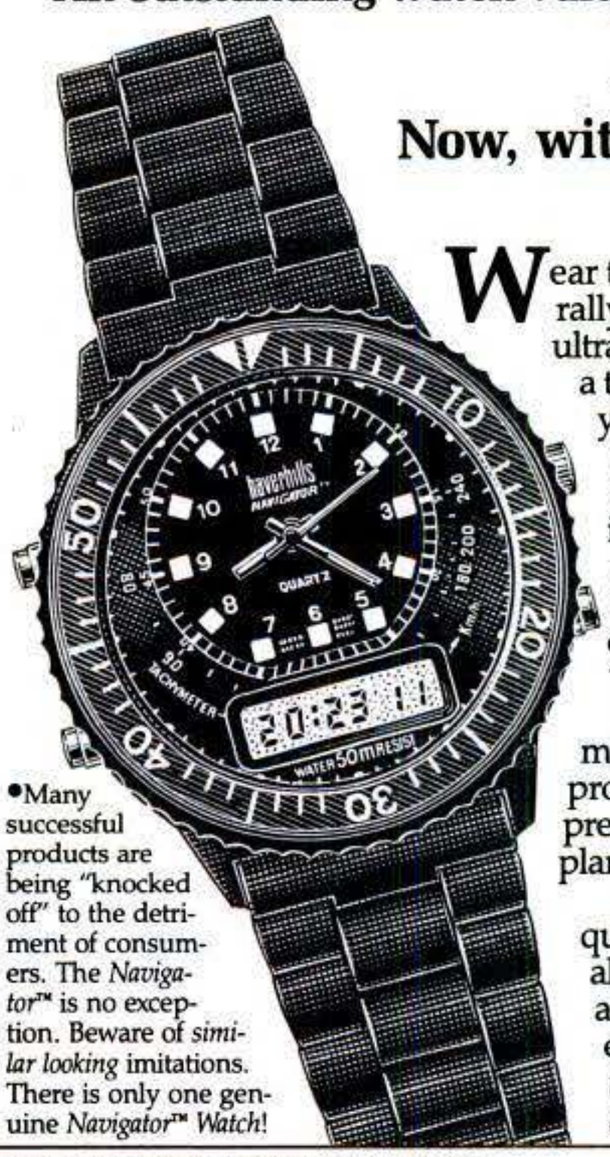

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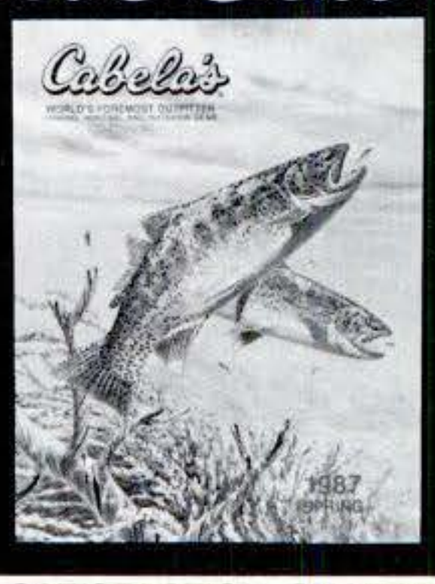

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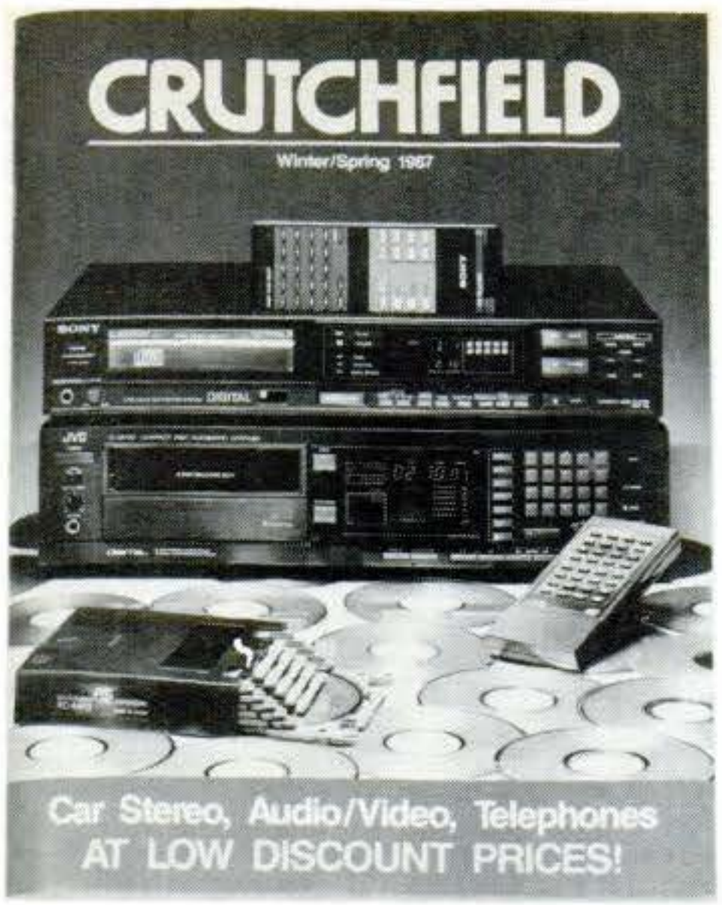

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Oil consumer

My 1985 Chevrolet S-10 with the 2.5-liter four-cylinder engine and manual transmission has only 6,000 miles on it, but it uses a quart of oil every 1,300 miles. It scored well on a leak-down test, it doesn't leak or burn oil, and the spark plugs look great. I use the recommended 5W-30 oil. Where is the oil going, and what should I do?

Bill Jepsen, Grand Island, Neb.

Car manufacturers don't consider one quart per 1,300 miles to be high oil consumption. I disagree with them, but you can expect to hear this rate called normal. Since you say there's no evidence of leakage, the engine has to be consuming the oil. The common reasons are broken or poorly sealing piston rings or leaky valve-stem oil seals. A leaky intake manifold can also cause oil to be sucked into the intake ports. Also, faulty plumbing in the crankcase venting system can send oil through the air cleaner and into the engine—where it doesn't always cause clouds of visible smoke. An important question: Did you allow the engine a reasonable break-in period with the factory break-in oil when it was new? This is essential to seating the rings properly so they will provide good oil control.

Fairmont fix

In your October 1986 column Harry Lawrence of Millerton, N.Y., wrote about his 1978 Ford Fairmont's weak acceleration. I had a 1978 Mercury with a transplanted Fairmont engine that had the same problem—dying when I stepped quickly on the accelerator. My mechanic located the problem and fixed it for $80. It turned out to be a bad "brain" in the ignition system.

Tom Savino, Staten Island, N.Y.

Thanks. I should have added the ignition module to the list of things to check. A module that's failing can definitely cause stalling and poor performance.

Rattle at start-up

My 1985 Mercury Marquis has 12,000 miles on it. I hear a bearing noise when the engine is first started after an oil and filter change. I change the oil and filter every 3,000 miles. Should I worry about this noise, or forget about it?

Charles Valach
Western Springs, Ill.

Your noise isn't a sign of a terminal problem. As a rule, the bearings should be durable enough to tolerate the momentary absence of oil pressure without wearing unacceptably.

Chronic rotor warp

I have a 1986 Toyota Celica GT Coupe. At 8,000 miles the brakes began to show signs of warped rotors, so the dealer turned them. At 9,200 miles the problem came back, and the dealer replaced the rotors, pads, and clips. Now at 10,500 miles the problem is back again. Do you have any idea what causes it?

Walter Garris Jr.
Murfreesboro, N.C.

Disc-brake rotors sometimes warp when rapidly heated, then cooled. This can occur during aggressive driving in traffic or in the mountains when it's raining, snowing, or just very cold outside. Once warped, a rotor will tend to warp again, even after it's been turned. A major service-related problem occurs when mechanics use air wrenches to over-tighten wheel-lug nuts. This can unevenly stress the rotors and cause them to warp.

Watery oil

I have a 1981 Ford F-100 pickup with the 255-cu.-in. V8 engine. The engine runs great, idles smoothly, and has plenty of power. But since the truck was new, water has been getting into the crankcase and diluting the oil, which I have to change every 500 to 700 miles. A Ford factory representative has checked cylinder compression, cooling-system pressure, the transmission cooler in the radiator, and the pollution equipment. The dipstick and the dipstick tube are rusty, and milky oil is being pushed up through the oil-fill cap and into the air cleaner. Nobody can explain this.

Lynn Smith, Statesville, N.C.

Though stop-and-go driving will cause some moisture to condense in the oil,

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the only place large quantities of water can come from is the cooling system. A leaking head gasket or intake-manifold gasket is probably the cause. If there is an internal leak, the only way you will find it is by disassembling the engine. You will be doing this soon in any case, if you keep running the engine with coolant in the oil; it's murder on bearings, cylinders, and valve guides.

Water injection

I've got a 1983 Toyota truck with a gasoline engine. I am wondering whether water injection would help my mileage, reduce ping, and reduce carbon buildup in the cylinders. Can it cause engine damage or cause the catalytic converter to clog faster? Also, will water injection help prolong exhaust-valve life in older cars when lead in gas is phased out?

Jim Bayly, Arleta, Calif.

Installing a water-injection system will cut down detonation and clean carbon from the cylinders without shortening catalytic-converter life. But water injection won't help the valves in older cars. In fact, it will increase wear and oxidation, especially of the exhaust valves. Your fuel mileage won't be affected.

CD ignition explained

Can you explain how a capacitor-discharge (CD) ignition system builds up such high voltage? The auto mechanics I have talked to do not understand it. They claim no more than 12 volts go into the coil. I'm told that the CD ignition systems used on outboard boat motors build primary coil voltage up to 200 volts or more.

John Agnew, Creston, Iowa

An automotive CD ignition has a step-up transformer that boosts the electrical system's 12 volts to about 600 volts, which is used to charge a capacitor. When the capacitor is triggered by breaker points or a magnetic pickup, the energy stored in it goes to the primary side of the coil—that's where the name "capacitor discharge" comes from. The coil now acts as a second step-up transformer, boosting the voltage that's delivered to the spark plugs to 45,000 to 50,000 volts. By the way,

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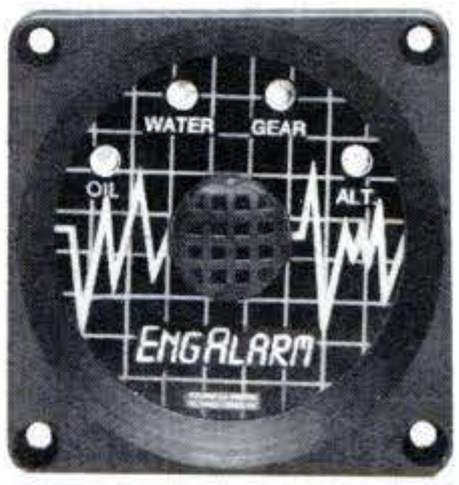

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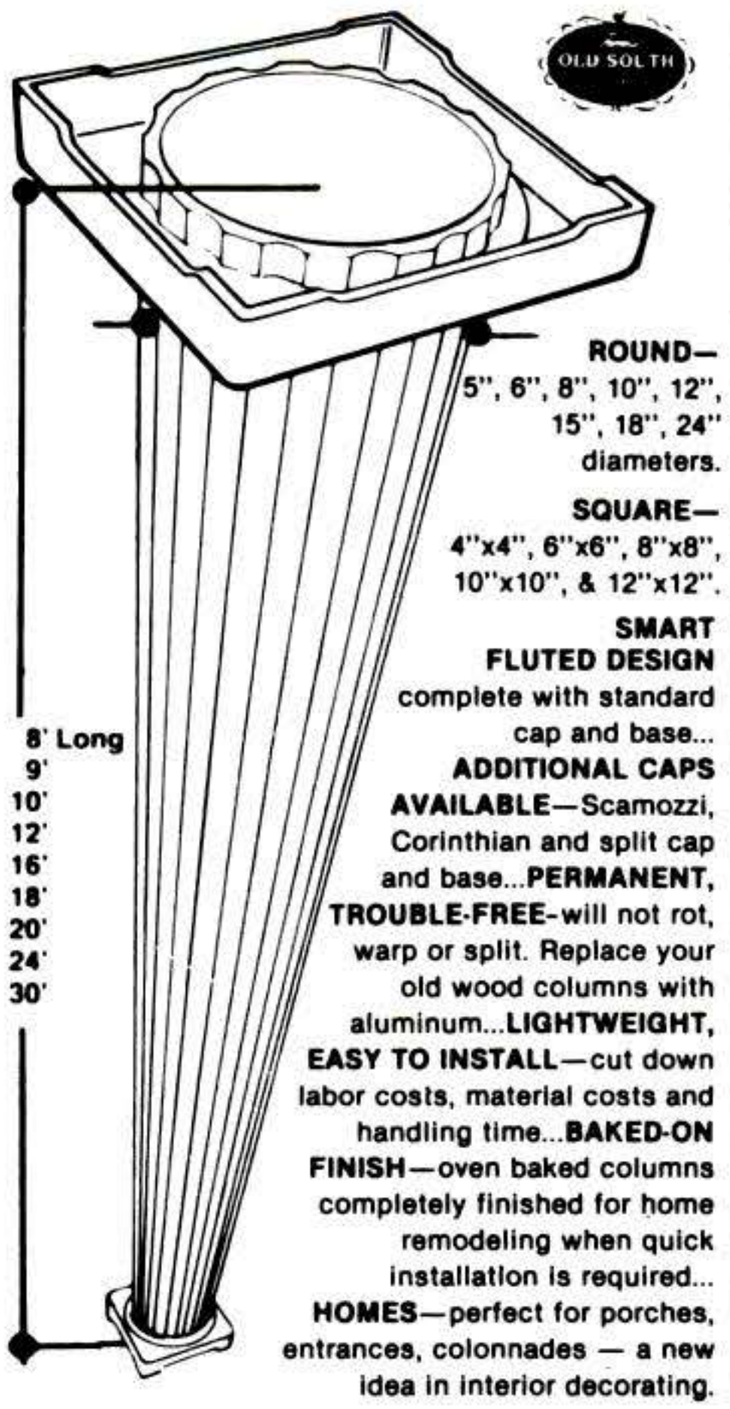

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thanks are due here to Russell Stephens of MSD Autotronic Controls in El Paso, Texas, for helping me explain these voltage-boosting systems in an understandable way.

Loping idle

The 2.2-liter engine in my 1982 Dodge Aries K lopes badly when it's first started. The problem seems to be that the choke stays too far closed for too long after cold start-up. It smooths out after the first block of driving, and thereafter it runs well. After three trips to the dealer, there is still no improvement. He has reset the timing, idle, and fast idle, and has replaced the following: choke element, temperature sensor for the hot-air door, and choke vacuum-delay valve. What could it be?

R. E. Bear, Oceanside, Calif.

Your engine doesn't have enough choke vacuum kick. Have the vacuum kicker reset to the latest published specs. Also check for a leaking exhaust-gas-recirculation (EGR) valve. The engine should have no EGR at idle.

Low-mile Mustang

I recently purchased a six-cylinder, three-speed 1970 Mustang with only 58,000 miles on the odometer. The car had been driven about 1,500 miles per year for the previous three years. It runs well, except that it uses a lot of oil—about one quart every 200 miles. I notice a little blue exhaust smoke at start-up, and more at high engine speeds. Compression is high—about 160 to 175 psi. If the oil-burning problem is related to improper storage, is there any way to rejuvenate the valve-stem seals or to free sticky piston rings without tearing down the engine?

Daniel J. Aucutt
Mount Prospect, Ill.

After 17 years of running and sitting around, your engine deserves to be torn down all the way to check whether the critical parts are in good condition, clean, and within factory specifications. If you avoid taking the engine apart and keep running it as is, you could end up doing some damage that will be more expensive than the cost of a preventive tear down. And some of

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those old parts are getting tough to find.

Water on the dipstick

My 1984 Ford E150 van with the 302-cu.-in. V8 engine has small water beads on the oil dipstick, which is rusty. I only see these water drops after an extended trip. Water has never been added to the radiator, so I do not believe any water is leaking into the crankcase. The van has 23,000 miles on it, and I change the oil every 4,000 miles. I have never seen any milky oil during an oil change. Where can the water be coming from?

Tom Steele, Spring, Texas

I believe the crankcase isn't getting enough ventilation, and I suspect the positive-crankcase-ventilation (PCV) system is to blame. It's either dirty, has the wrong valve installed, or has a plumbing leak or error. The water condensation and rust are caused by water vapor that should have vented to the intake side of the engine.

Too-quick fix?

From the time it was delivered, my 1986½ Nissan Hardbody pickup with five-speed manual transmission has thrown oil out of the breather atop the transmission. The dealer told me that this condition exists on all the Hardbody and four-wheel-drive truck transmissions. He says the approved Nissan fix is to attach a hose to the breather, run it to the engine compartment, and put a gasoline-type plastic reservoir filter on the top end. Nissan so far has not responded to my letters. Do you recommend that I accept this fix, or push for a better solution?

Wilbur Prim, Camarillo, Calif.

I'd insist on a truck that works—at least when it's brand new. I don't consider a vehicle with a pressure build-up in the transmission that causes oil to blow out to be worth a whole lot. Why should you have to put up with a Mickey Mouse solution to their problem?

Got a car problem? Send it to "Say, Smokey—," POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters not selected for publication.

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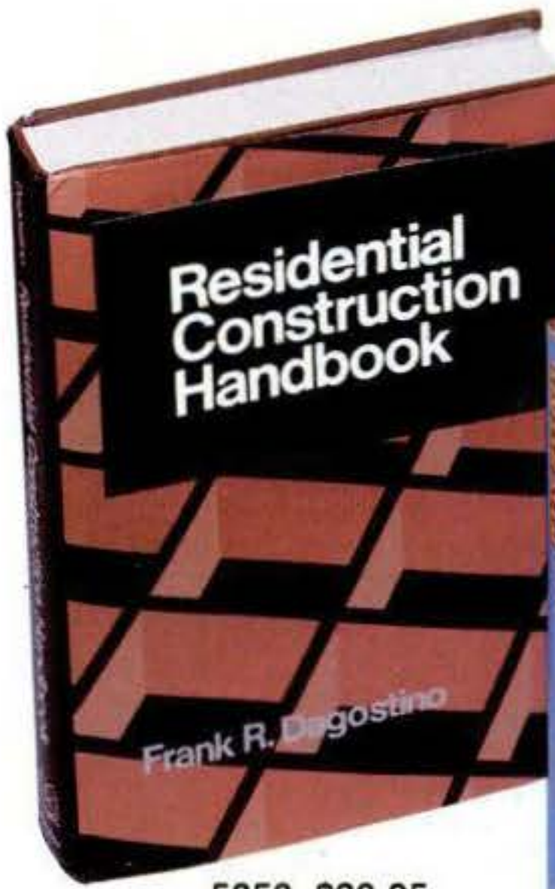

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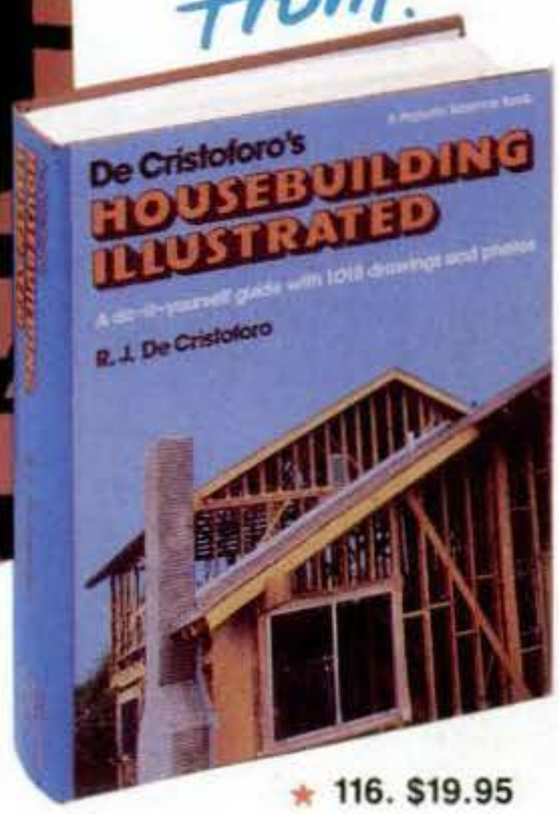

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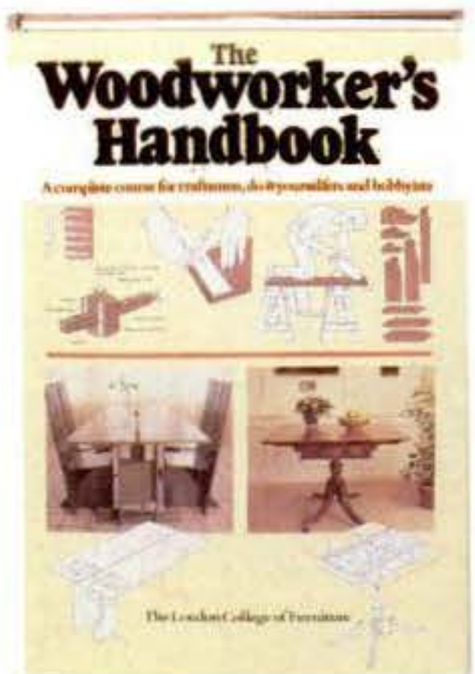

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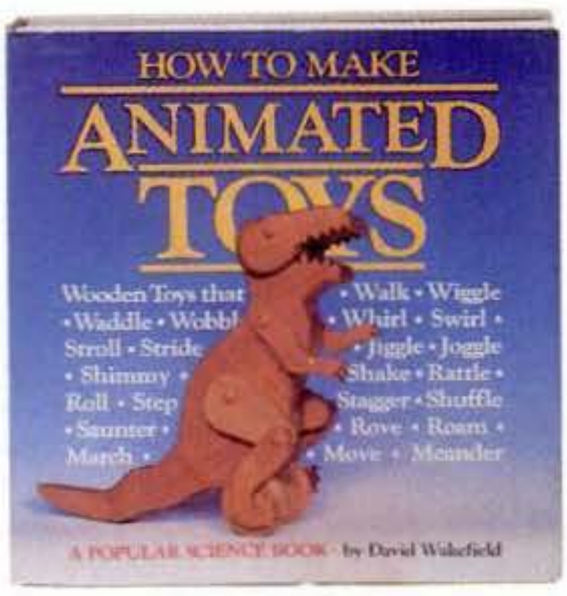

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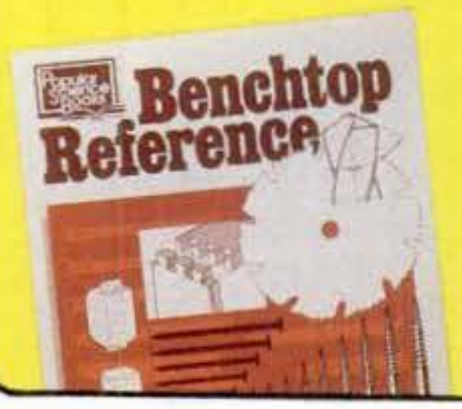

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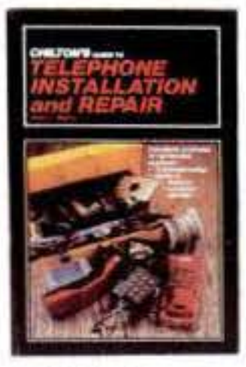

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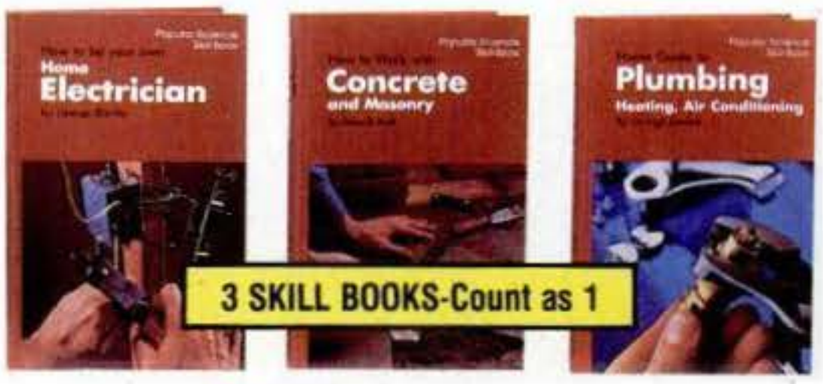

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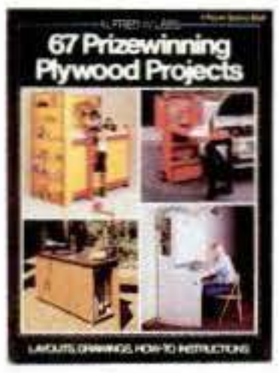

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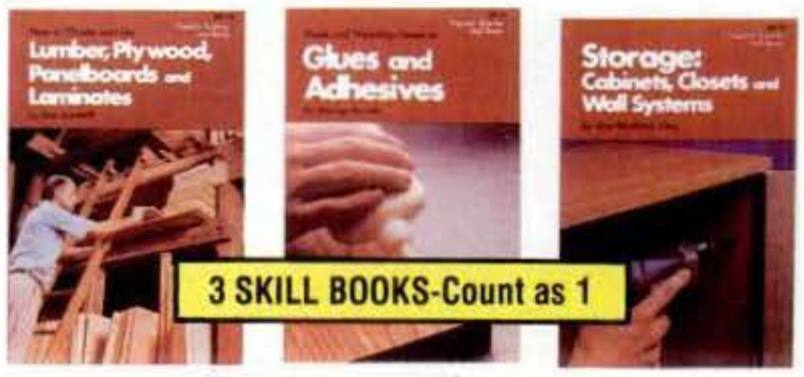

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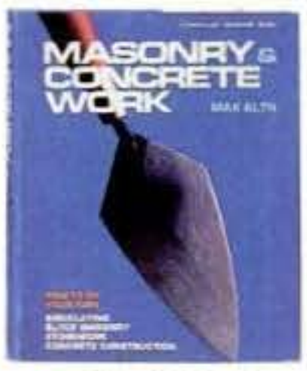

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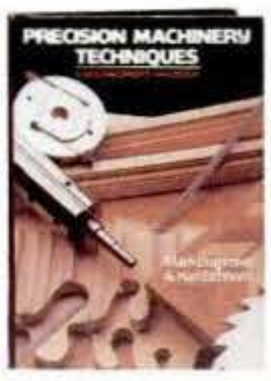

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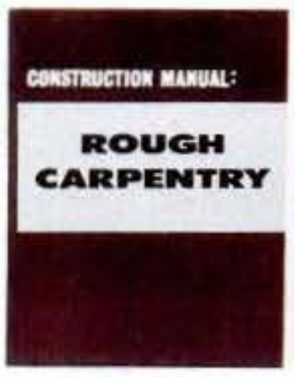

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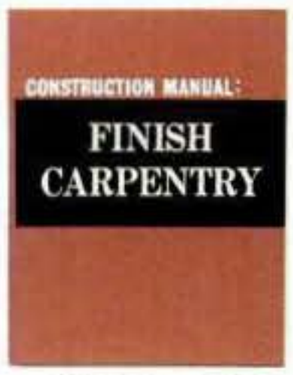

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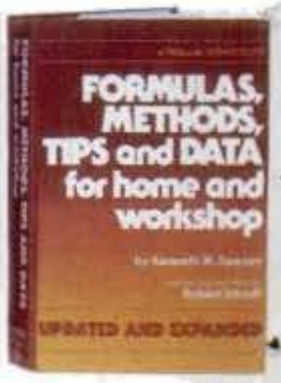

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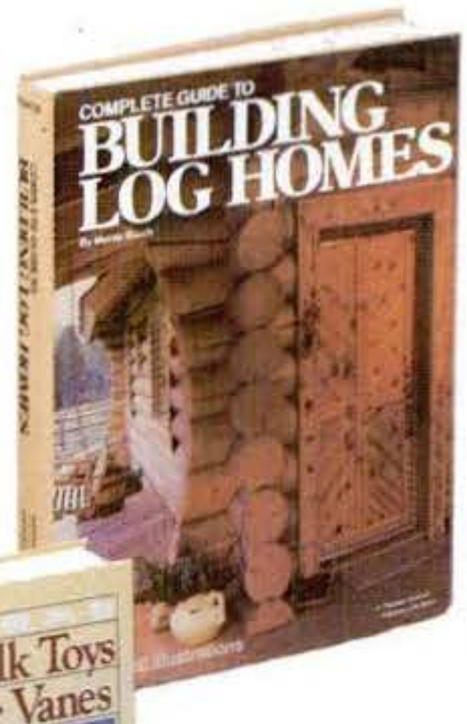

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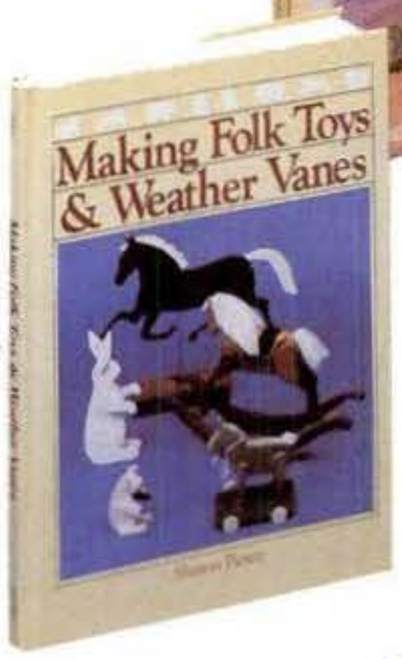

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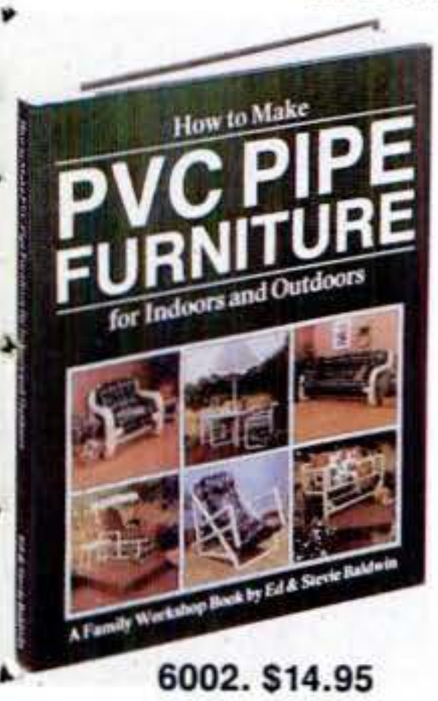

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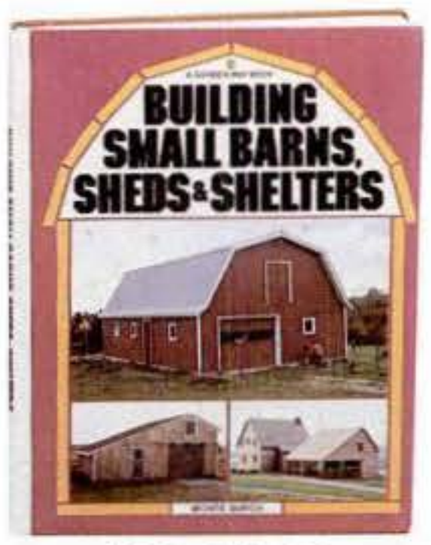

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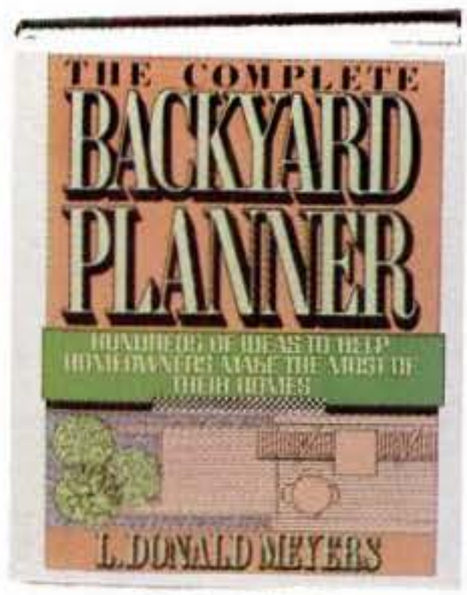

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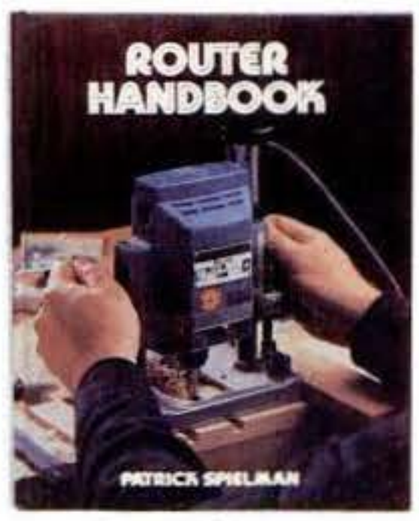

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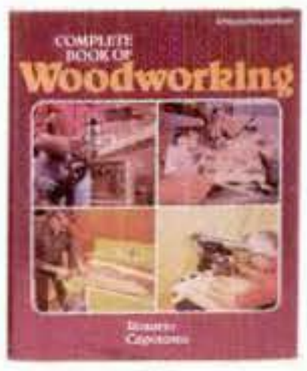

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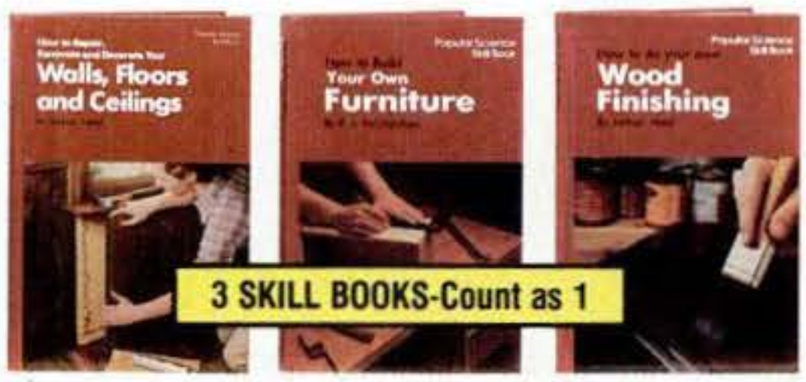

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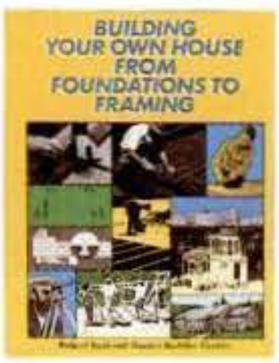

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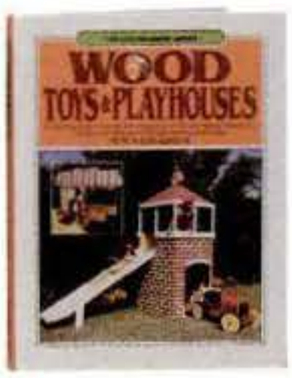

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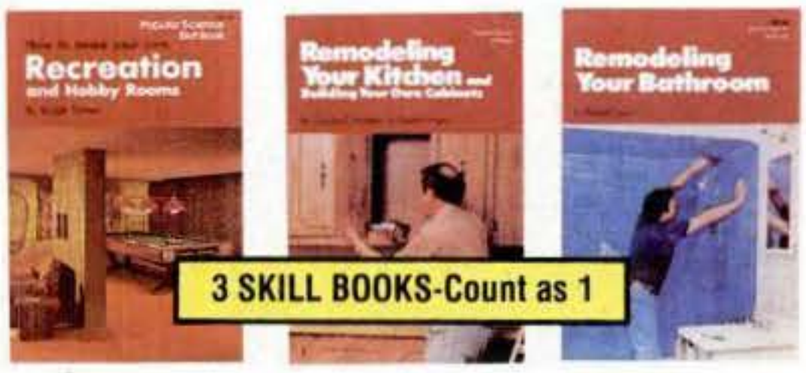

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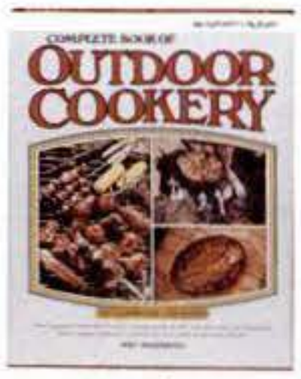

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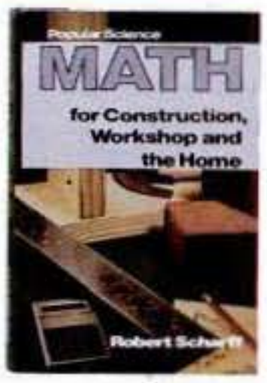

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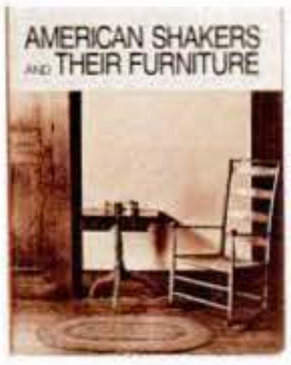

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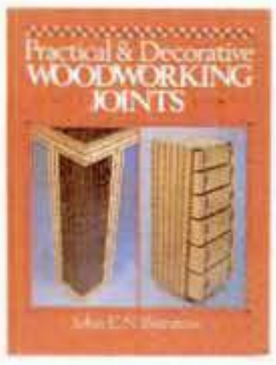

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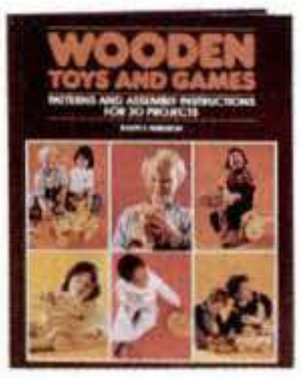

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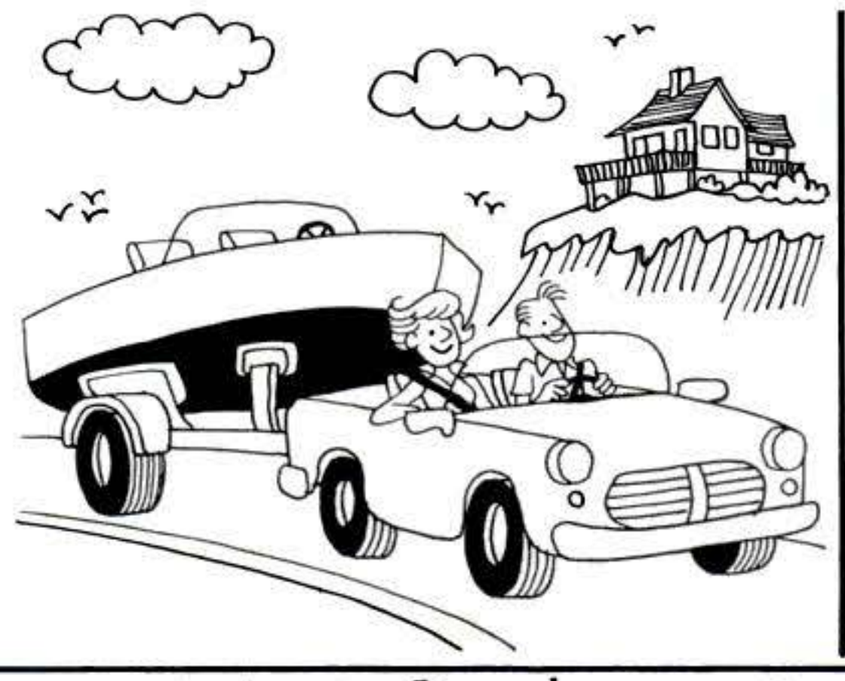

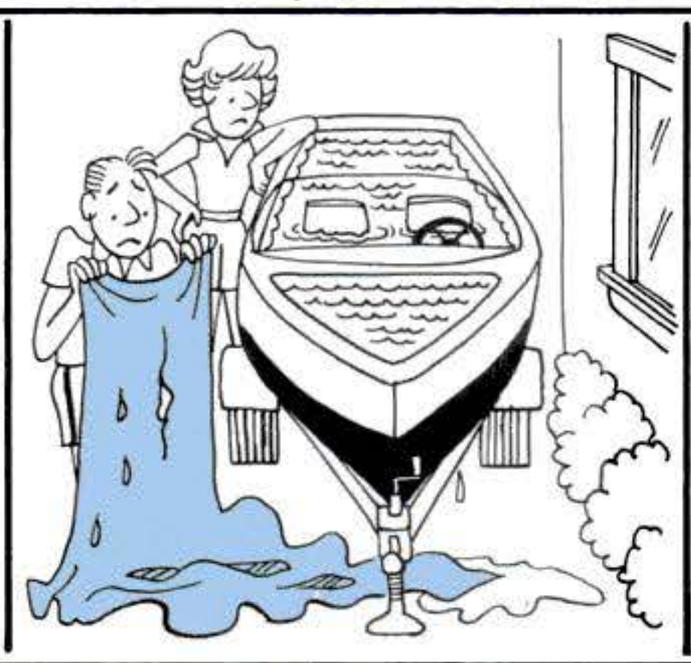

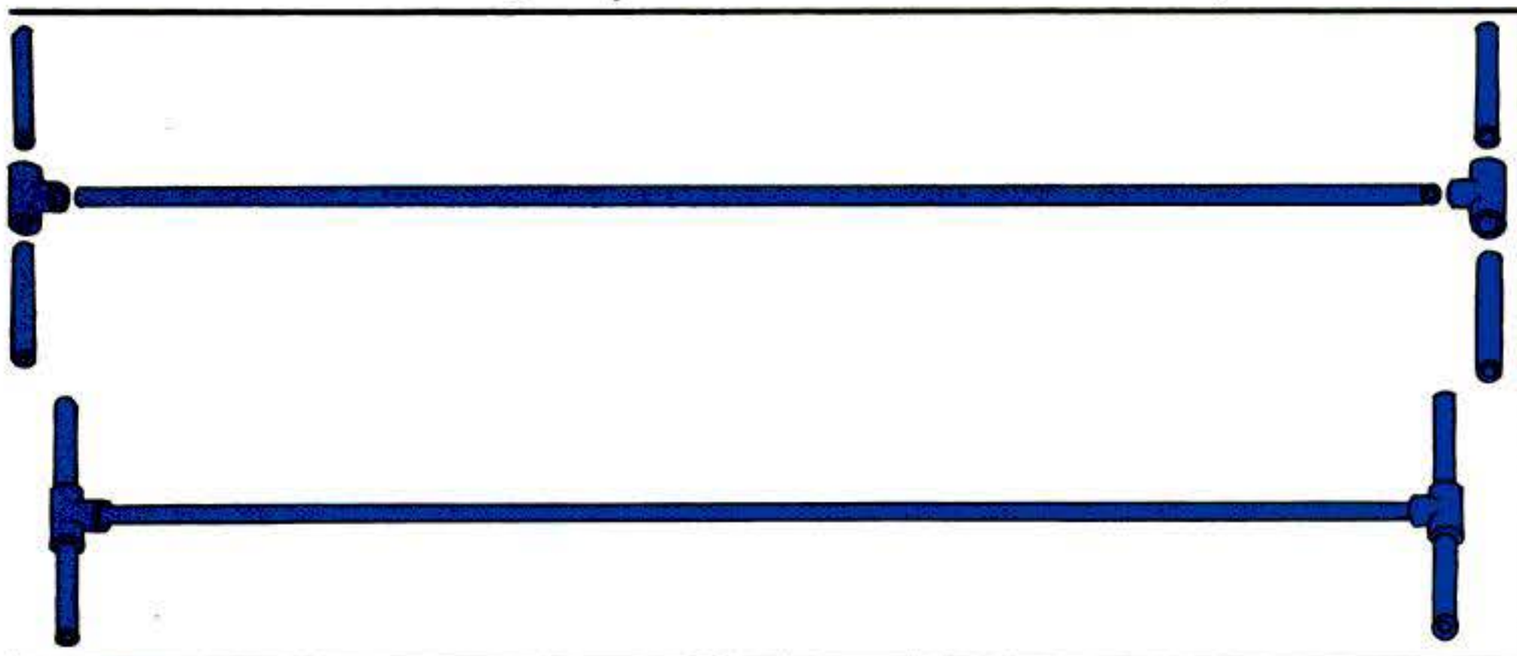

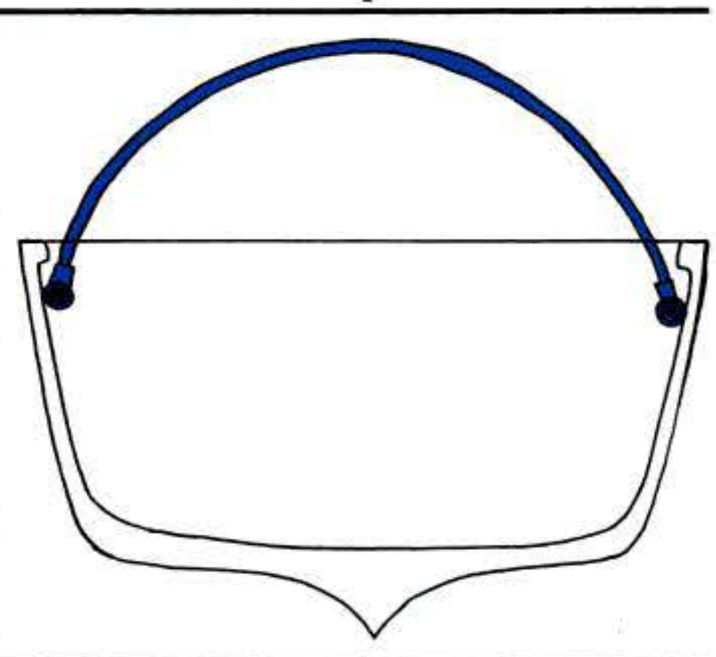

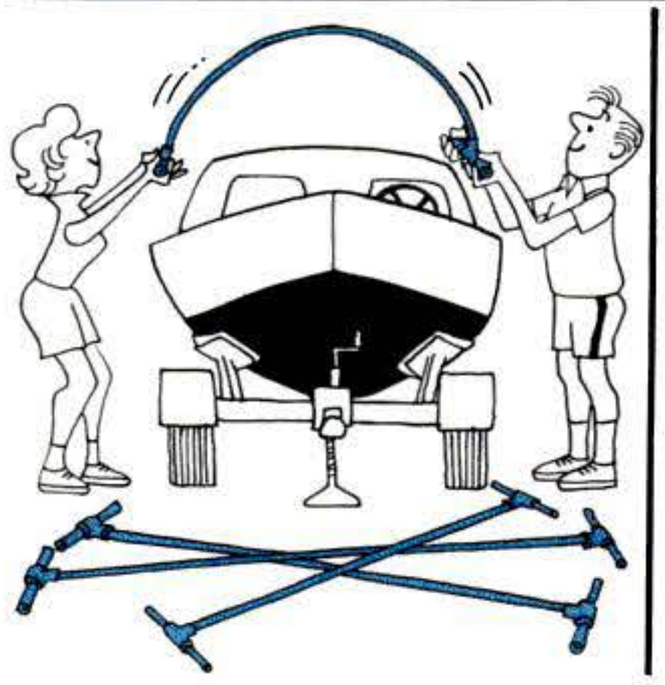

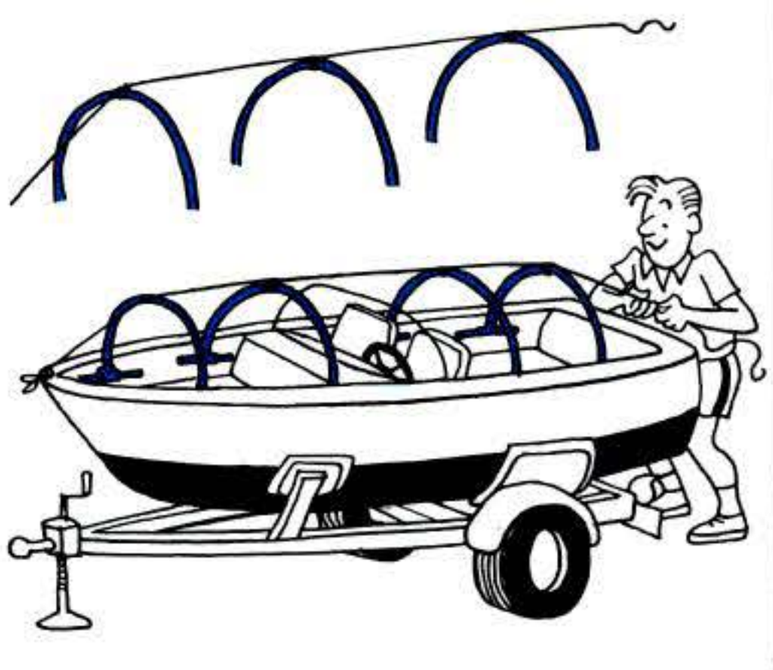

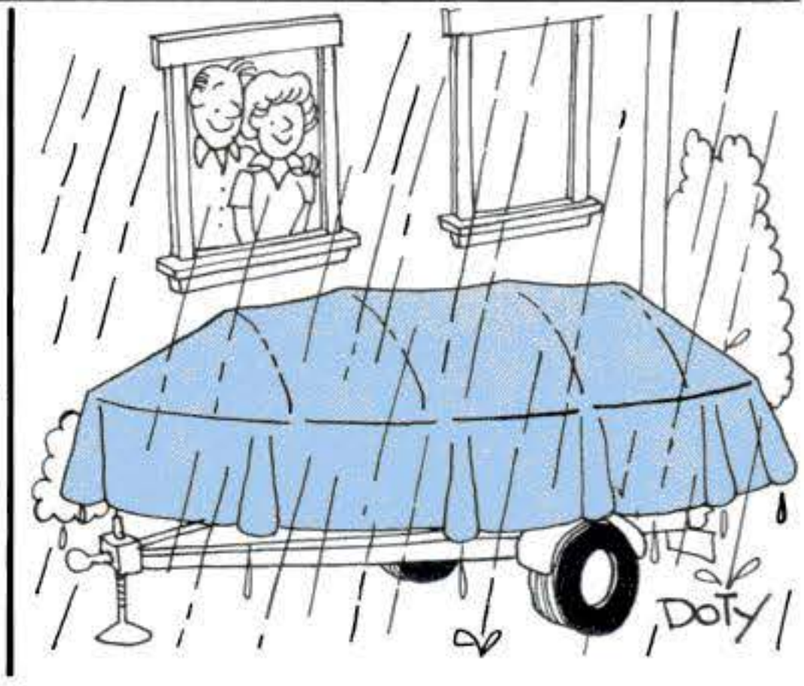

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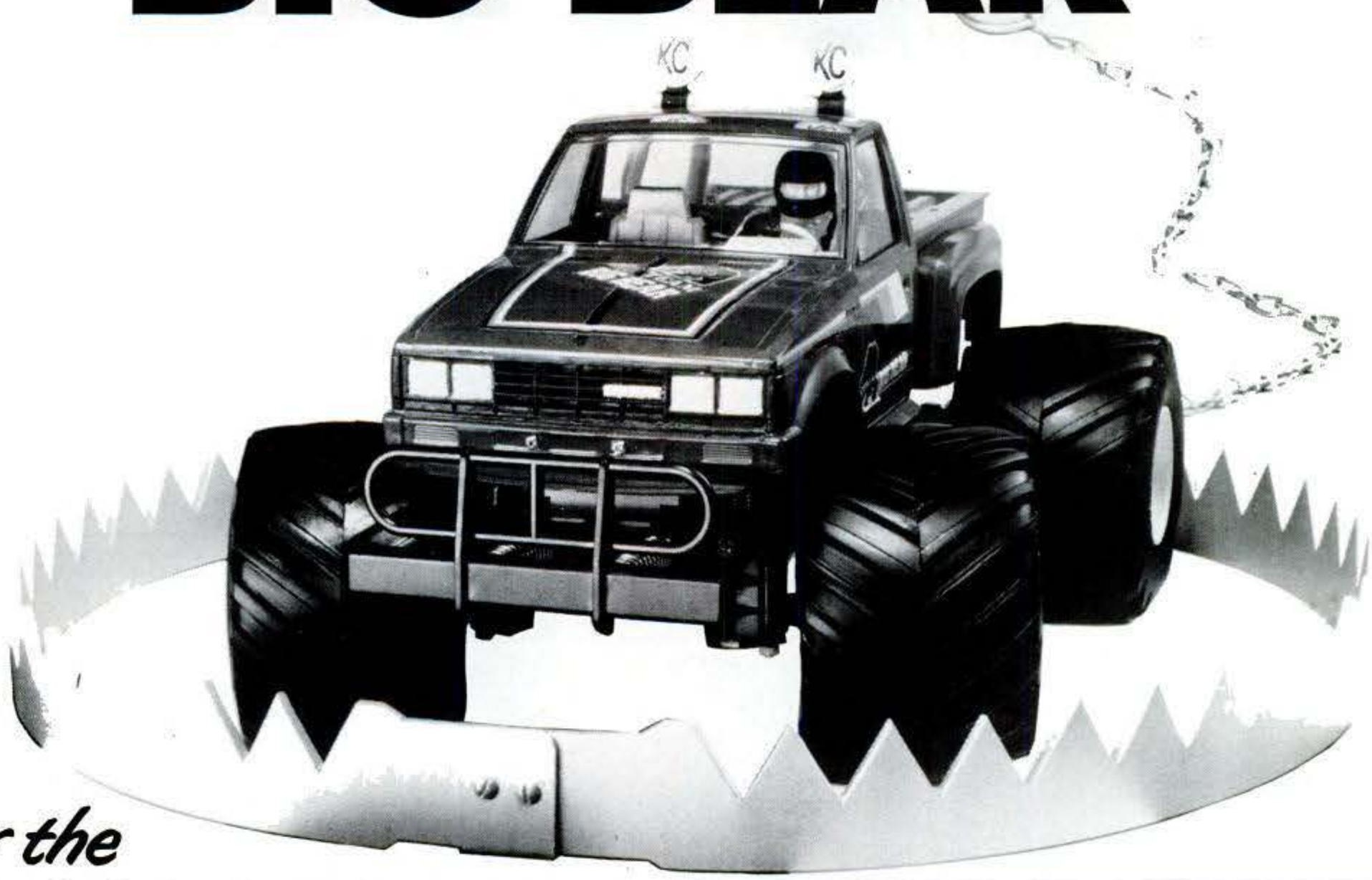

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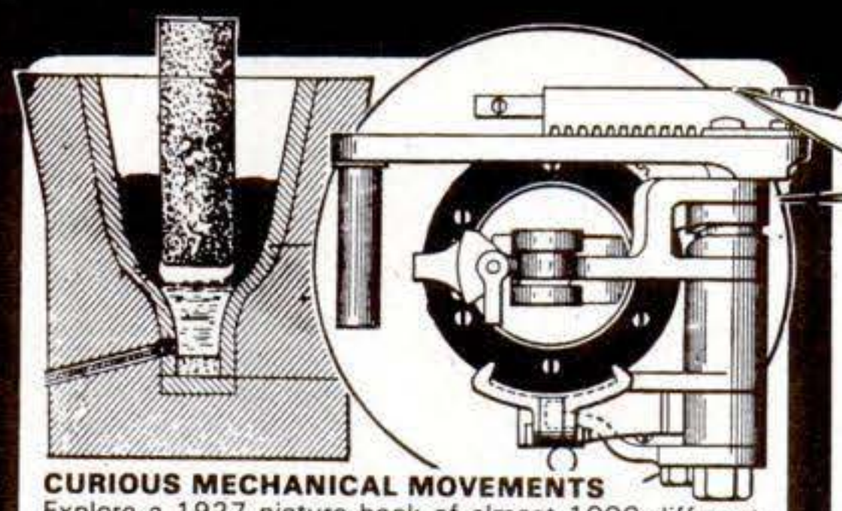

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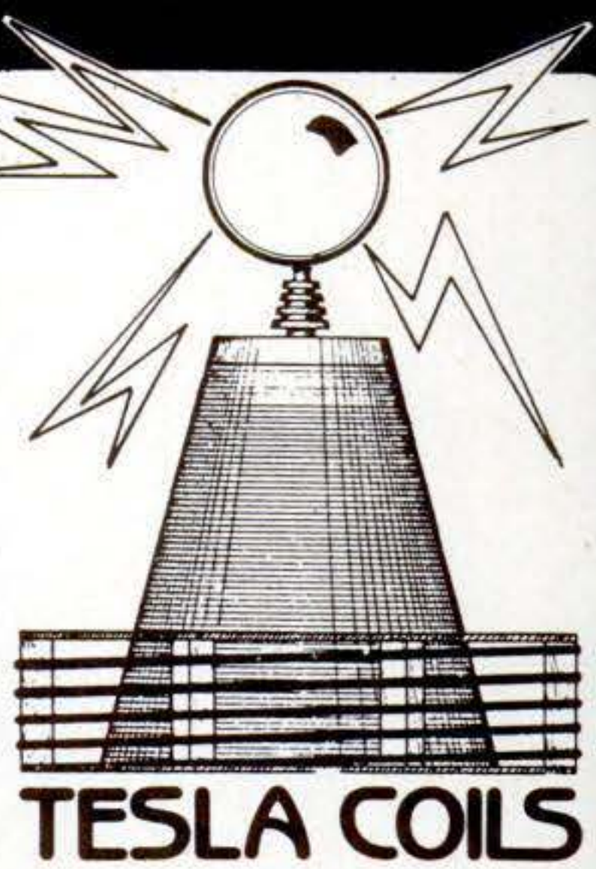

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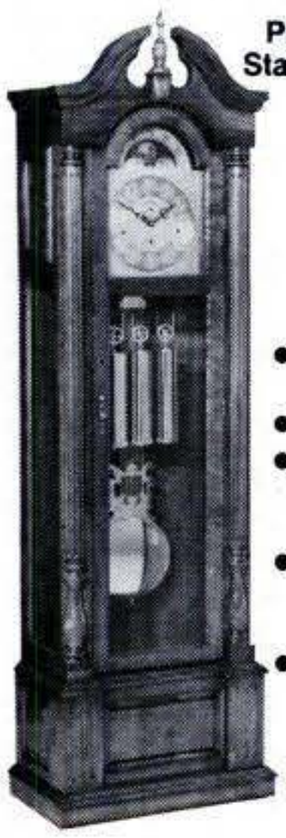

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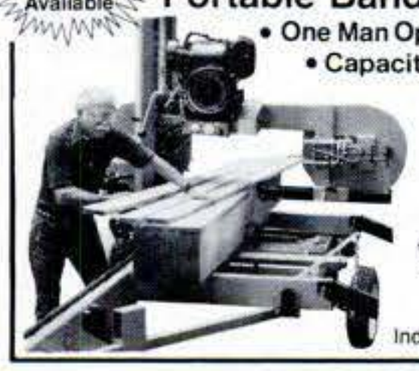

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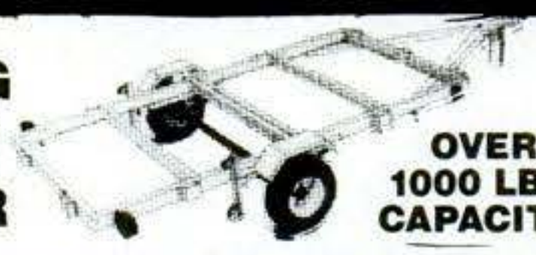

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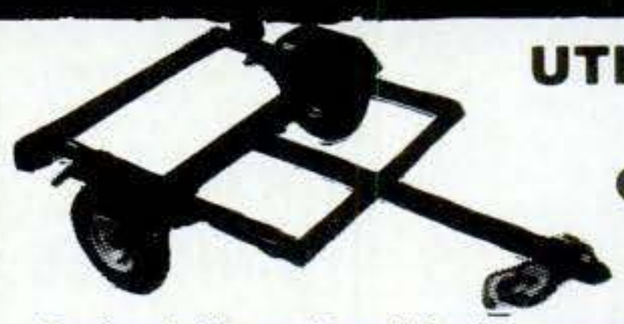

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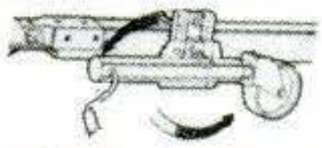

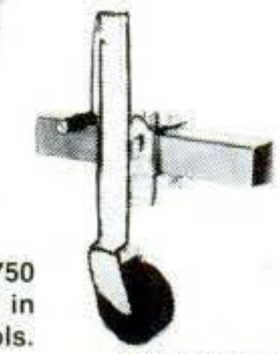

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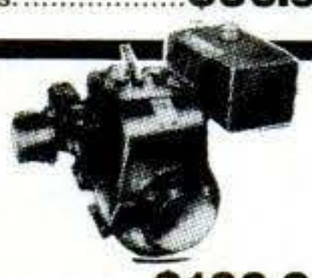

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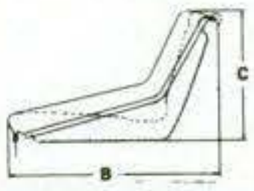

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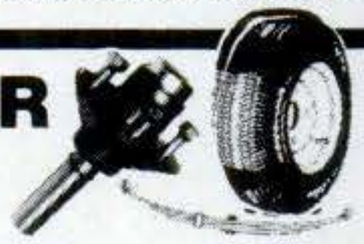

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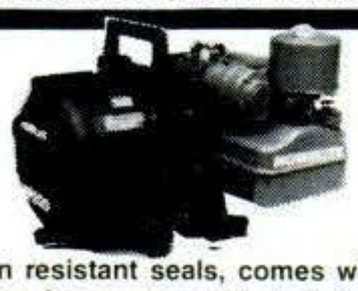

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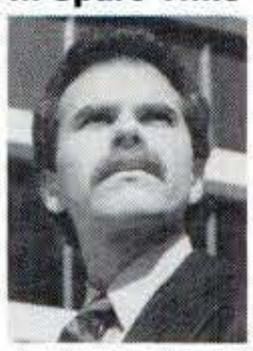

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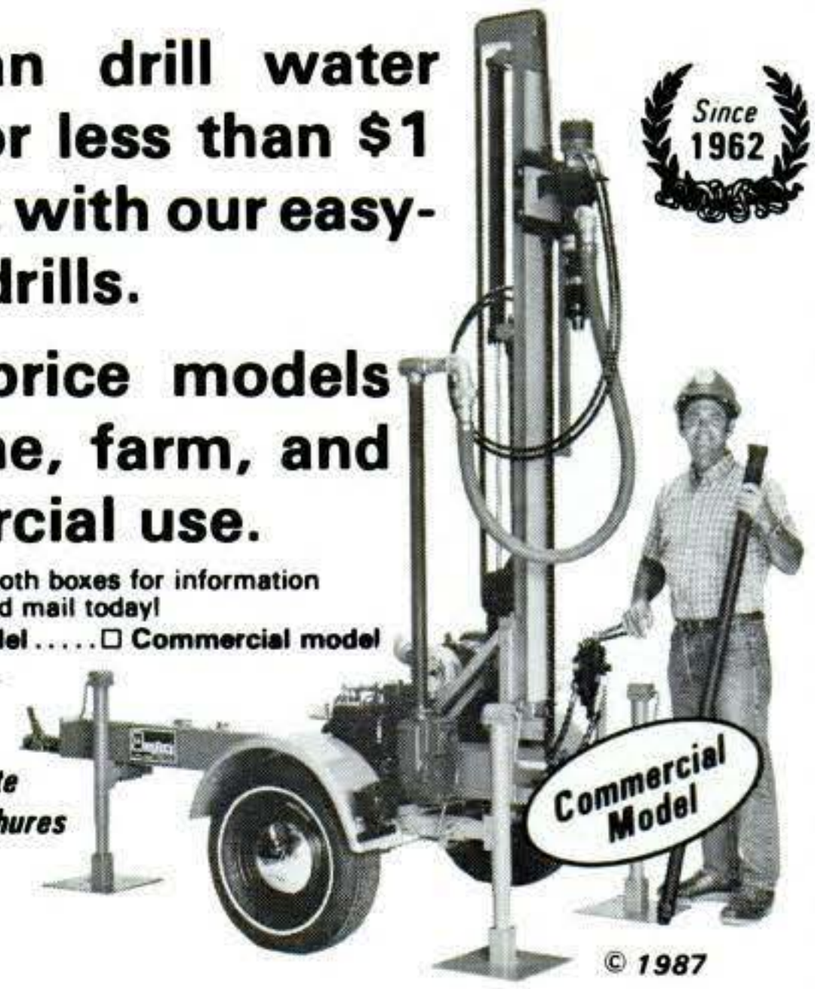

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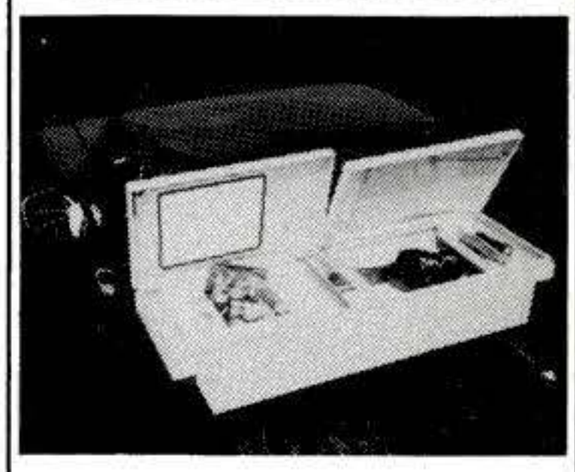

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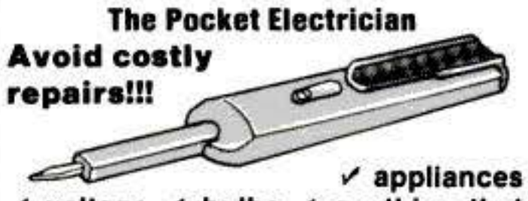

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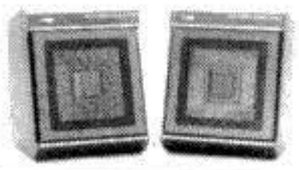

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